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ABSTRACT

Two single subject multiple probes across subjects research studies were conducted to evaluate the effectiveness of two instructional writing programs. The objective of the first study was to determine the effect of an instructional program on the selection of initial letters of words by 3 children with developmental disabilities (ages 7-10) who used augmentative and alternative communication (AAC). The writing instructional program included direct instruction in letter-sound correspondence and selection of initial letters of words, and a writing workshop-type of activity to provide instruction in writing tasks. Two of the 3 children were successful in the acquisition of the target skill, maintained use of the skill at least 1 month following instruction, and demonstrated some generalization. The goal of the second study was to determine the effect of an instructional program on the selection of final letters of words by 2 children with developmental disabilities (age 10) who used AAC and who had mastered the selection of initial letters of words. The instructional program included direct instruction in the selection of final letters, a review of the selection of initial letters, and a writing workshop-type of activity. Both participants were successful in acquiring the target skill. Appended are the following items from Study 1 and Study 2, respectively: Organization of words for Instructional Stimuli and Probes; The Instructional Program--Initial Letter; and Sample Data for Selection of Initial Letter in a Writing Task. (Contains 57 references.) (Author/CR)

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EXEMPLARY PRACTICES IN WRITING INSTRUCTION FOR YOUNG CHILDREN WHO USE AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

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The Effect of an Instructional Program on the Early Writing Skills of Children Who Use Augmentative and Alternative Communication

ABSTRACT

Two single subject multiple probe across subjects research studies were conducted to evaluate the effectiveness of two writing instructional programs. The objective of the first study was to determine the effect of an instructional program on the selection of initial letters of words by three children with developmental disabilities (ages 7 to 10) who used AAC. The writing instructional program included direct instruction in letter-sound correspondence and selection of initial letters (i.e., s, d, c, f, b) of words, and a writing workshop-type of activity to provide instruction in writing tasks. Two of the three children were successful in the acquisition of the target skill, maintained use of the skill at least one month following instruction, and demonstrated some generalization of the skill to less structured tasks. The goal of the second study was to determine the effect of an instructional program on the selection of final letters (i.e., p, n, r, l, d) of words by two children with developmental disabilities (age 10) who used AAC and who had mastered the selection of initial letters of words. The instructional program included direct instruction in the selection of final letters, a review of the selection of initial letters, and a writing workshop-type of activity. Both participants were successful in acquiring the target skill, maintaining skill use at least one month following instruction, and partially generalizing the skill to less structured tasks. The results of the studies suggest that through an instructional program that combines a direct instruction approach and a whole language approach, children who use AAC may be able to develop phonemic awareness skills and apply those skills to writing tasks.

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The Effect of an Instructional Program on the Early Writing Skills of Children Who Use Augmentative and Alternative Communication

CHAPTER 1

INTRODUCTION

Significance of the Problem

There are more than two million individuals in the United States with severe communication impairments (American Speech-Language-Hearing Association, 1991). Communication impairments may be the result of a number of acquired disorders (e.g., traumatic brain injury) or congenital disorders (e.g., cerebral palsy). These individuals are unable to use speech as their primary means of communication and require the use of augmentative and alternative communication (AAC). AAC encompasses a wide range of communication methods including: gestures, communication boards, and computer-based voice output systems (Glennen & DeCoste, 1997). Individuals who use aided AAC systems (i.e., systems external to the individual's body), such as communication boards or computer-based voice output systems, require the vocabulary of the system to be represented by tangible symbols (e.g., real objects, miniature objects, partial objects), representational symbols (e.g., photographs, line drawings) or orthographic symbols (e.g., letters,

words, sentences) (Beukelman & Mirenda, 1998). Individuals who are unable to read or write are unable to use vocabulary represented orthographically, and therefore must rely on tangible or representation symbols. This severely restricts an individual's generative capacity during communicative interactions because the individual who uses AAC must rely on a partner to predict necessary vocabulary and provide the pictorial representations prior to the communicative interaction. One of the benefits of having functional literacy skills is that an individual who uses AAC, given access to a system with an alphabet board or keyboard, may spontaneously generate vocabulary during conversations. In addition to enhancing the communication of individuals who use AAC, functional literacy skills are critical for the fulfillment of educational, vocational, and social opportunities.

It has been well documented that children with significant physical and communication disabilities who use AAC are at risk for the development of functional literacy skills (Kelford Smith, Thurston, Light, Parnes, & O'Keefe, 1989; Koppenhaver & Yoder, 1993; Smith, 1992). It has been estimated that approximately 70% to 90% of individuals who use AAC demonstrate severe literacy-learning difficulties (Koppenhaver, Steelman, Pierce, Yoder, & Staples, 1993).

Formal instruction is required for the full development of functional literacy skills. The development of written language is a language process that begins before children enter school. As with spoken language, written language develops, in part, through exposure to its functional applications and through participation in its actual use to accomplish tasks (e.g., Atwell, 1987; Calkins, 1994; Koppenhaver et al., 1993;

Pierce & McWilliam, 1993). Critical early literacy experiences include independent access to play with print materials and active participation in literacy-related activities (e.g., scribbling, drawing, and writing) (Koppenhaver et al., 1993). Fine and gross motor impairments of children with significant physical and communication disabilities often result in restricted use of conventional writing tools (e.g., pencil, crayon) during play activities and early literacy experiences (Pierce & McWilliam, 1993). A study comparing the home literacy experiences of preschoolers who used AAC to nondisabled preschoolers showed that the households of the two groups were similar. The range of literacy materials and models of family members writing were equivalent for both the preschoolers who used AAC and the nondisabled preschoolers. However, the children who used AAC had fewer opportunities to use printed materials and to participate in writing/drawing activities (Light & Kelford Smith, 1993). Without access to literacy activities, children who use AAC are placed at risk for the development of early literacy skills.

Children who enter school with less than age appropriate early literacy skills require even more direct instruction compared to children with average home literacy experiences (e.g., Graham & Harris, 1994; Stahl et al., 1998). Therefore, children who use AAC must be provided with access to literacy instruction in school; moreover, children who use AAC will probably require even more direct instruction in literacy skills than their nondisabled peers. As early as kindergarten, children without disabilities benefit from explicit instruction in literacy skills (e.g., identifying letters, matching letters to the corresponding sounds) (e.g., Liberman & Liberman,

1990; Lundberg, Frost, & Peterson, 1988; Stahl, Duffy-Hester, & Stahl, 1998). However, the existing instructional programs for school-aged children without disabilities rely heavily on both the teacher's and children's speech productions (e.g., Adams, 1990). Therefore, children with significant speech impairments have considerable difficulty participating within these programs in meaningful ways and are at serious risk for developing phonemic awareness and letter-sound correspondence skills following the existing instructional programs (Foley, 1993). Appropriate adaptations are necessary to facilitate the participation of children with disabilities in literacy instructional programs; however, there is a critical lack of research evaluating the efficacy of instructional approaches to teach literacy to children who use AAC (Foley, 1993; Glennen & DeCoste, 1997). In fact, to date, there is no research identifying empirically validated best practices for teaching early writing skills to children who use AAC. The result is that children who use AAC often do not receive appropriate instruction for the development of functional writing skills. Research has demonstrated that children with disabilities receive quantitatively and qualitatively less literacy instruction than their nondisabled peers (e.g., Koppenhaver & Yoder, 1990b, Koppenhaver & Yoder, 1992).

Research has shown that more instructional time is spent on reading than on writing with children with disabilities (e.g., Koppenhaver & Yoder, 1990b, Koppenhaver & Yoder, 1992). Writing remains the most neglected aspect of literacy instruction, research, and experience in the lives of individuals who use AAC (Foley, 1993; Glennen & DeCoste, 1997; Koppenhaver, 1992). One reason that writing

instruction may be emphasized less is that writing is considered to be more difficult than reading; there are additional memory demands required in encoding sequences of individual letters and words compared to decoding a static sequence of letters and words (Ehri, 2000). Moreover, for individuals with severe physical impairments, the slower rate of encoding (i.e., due to alternative modes of access) will further increase memory demands. Another reason writing may be neglected in instruction with individuals who use AAC, is that novel writing may be a very time consuming and frustrating process for individuals who use AAC who are in the early stages of developing literacy skills. An individual who is developing literacy skills may use incorrect spellings of words in novel writing (i.e., invented spelling); consequently, the reader may not be able to identify the target words. In addition, the individual who uses AAC may not have access to appropriate vocabulary to assist the reader in identifying the target words. Despite the challenges of instruction in writing (i.e., especially novel writing), it is critical to provide individuals who are beginning to develop literacy skills access to authentic writing experiences (e.g., Adams, 1990, Scott, 2000).

The paucity of classroom-based instructional writing programs place children who use AAC at serious risk for developing functional literacy skills (Glennen & DeCoste, 1997). Poorly developed literacy skills negatively affect children's self-expression, independence from caregivers and aides, links to written information (e.g., Internet use, personal correspondence, literature), recreational opportunities, educational opportunities, employment opportunities, and overall participation in a

highly literate society (e.g., Kelford Smith et al., 1989; Light & McNaughton, 1993). It is critical that children with significant physical and communication disabilities who use AAC have access to effective classroom-based writing instructional programs to develop functional writing skills.

Review of the Literature

Due to the absence of writing instructional programs and empirical research supporting approaches to teaching writing for children who use AAC, the general principles identified as best practices for children without disabilities may be used as a guide. Gerber and Kraat (1992) made a similar argument in their discussion of using a normal language developmental model as a guide for language intervention for children with developmental disabilities who use AAC. Children who use AAC frequently have an uneven profile of cognitive, social, and language skills partially due to restrictions in their expressive language (i.e., relying on a mode of communication that is less efficient than natural speech); therefore, strictly following the sequence of developmental norms may not be appropriate (Gerber & Kraat, 1992). Ideally, information from the developmental norms of children without disabilities should be considered in addition to descriptive information about the unique needs of children who use AAC. Because of the lack of research in literacy intervention programs with children who use AAC, the essential skills specified in the developmental model of normal literacy acquisition should be used as the content of

the program, with special adaptations to accommodate the unique needs of children who use AAC. For example, an adaptive keyboard may be used to eliminate the need to grasp a pencil during writing activities for children with limited motor skills. Furthermore, partner-assisted scanning may be used with an adaptive keyboard for children with severe physical disabilities who are unable to use direct selection.

The principal considerations in designing a formal instructional program targeting early literacy skills are: (1) the content of the program (i.e., the target skills); (2) the instructional approach (e.g., direct instruction, whole language, or a combination of the two approaches); and (3) the required adaptations to accommodate motor and speech impairments.

Instructional Content

Research with individuals without disabilities has demonstrated that the best predictor of success in literacy development is phonological awareness (e.g., Ehri, 2000; Liberman, Rubin, Duques, & Carlisle, 1985; Nation & Hulme, 1997). Phonological awareness is the ability to discriminate and manipulate individual phonemes or word segments (e.g., syllables, onsets, and rimes) of spoken language (Blachman, 1994). Phonemic awareness refers more specifically to the knowledge that spoken words may be divided into sound segments (i.e., phonemes) (Ball & Blachman, 1991; Mann, 1986). Research has identified phonemic awareness as one of the most important factors influencing children's development of spelling (e.g., Ehri, 2000; Liberman, Rubin, Duques, & Carlisle, 1985; Nation & Hulme, 1997). Moreover, phonemic awareness and spelling appear to have a reciprocal relationship.

Improvement in phonemic awareness results in improved spelling, and instruction in spelling has been shown to result in improved phonemic awareness (Masterson & Apel, 2000; Tangelman & Blachman, 1992). It is generally accepted that regardless of the approach to writing instruction (e.g., direct instruction, whole language, balanced), a program should include a component targeting instruction in phonemic awareness (e.g., Ehri, 2000; Spector, 1995; Traweek & Berninger, 1997).

There has been some research addressing phonological awareness and individuals who use AAC. Research has shown that individuals with severe congenital speech impairments have the ability to develop phonological awareness despite limited speech skills (e.g., Dahlgren Sandberg & Hjelmquist, 1996; Foley & Pollatsek, 1999). Vandervelden and Siegel (1999) assessed the phonological awareness skills of three groups of participants: individuals with cerebral palsy with no intelligible speech, individuals with impaired but intelligible speech, and individuals without disabilities matched for reading-levels. The results indicated that overall, the individuals without disabilities performed higher than the individuals with disabilities. Furthermore, the individuals with no intelligible speech and the individuals with impaired but intelligible speech demonstrated difficulties in using letter-sound correspondence skills to spell, despite success in using letter-sound correspondence skills to read unfamiliar words. Foley and Pollatsek (1999) investigated the phonological awareness skills of individuals with congenital speech impairments with no intelligible speech and individuals with moderate to severe congenital speech impairments. The results of the study demonstrated that although

both groups of individuals with speech impairments demonstrated success in some of the phonological awareness tasks, they did not perform as well as individuals of the same ages and reading levels.

One of the phonemic awareness skills that is critical for the development of writing is segmentation (Ehri, 2000; Nation & Hulme, 1997; Stahl et al., 1998). Segmentation (i.e., identification the first sound of a word) has been shown to be a predictor for the development of reading and spelling skills; moreover, the assessment of segmentation skills is often used as an indication of emerging spelling skills (Masterson & Apel, 2000; Nation & Hulme, 1997). In general, children learn to identify initial word sounds first (Stahl et al., 1998). As expected, the earliest developing form of phonemic awareness is the segmentation of the onset of one-syllable words, or the first sound in a word (Vandervelden & Siegel, 1995). Following the development of skills in segmentation of the first sounds is the development of skills in segmentation of final sounds in words (Vandervelden & Siegel, 1999). Later developing phonemic awareness skills include segmentation of all individual sounds in a word, or the manipulation of specific sounds in words (e.g., deletion of sounds, substitution of sounds) (e.g., Blachman, 1984; Nation & Hulme, 1997; Vandervelden & Siegel, 1995, 1999).

It has been shown that it is important not only that children develop phonemic awareness, but also that they understand that phonemes are represented by alphabetic orthography (i.e., letter-sound knowledge). A number of studies have compared instruction in phonemic awareness alone, letter-sound correspondence alone, and

phonemic awareness with letter-sound correspondence; results demonstrate that it is the combination of phonemic awareness and letter-sound instruction that facilitates the most success in beginning reading and spelling (e.g., Ball & Blachman, 1988, 1991; Blachman, 1989; Bradley & Bryant 1983, 1985; Cunningham, 1995; McGuinness, McGuinness, & Donohue, 1995). Without both phonemic awareness and letter-sound knowledge, children are likely to become poor readers and spellers (Tangel & Blachman, 1992).

In summary, according to the research with children without disabilities, the skills critical for the development of an early writing instructional program are segmentation of the initial sound of words and letter-sound correspondence. Segmentation has been shown to be a strong predictor for the development of early spelling skills (Masterson & Apel, 2000; Nation & Hulme, 1997). Furthermore, in addition to segmentation skills, the development of letter-sound correspondence is also critical for the development of early writing skills (e.g., Cunninham, 1995; McGuinness, McGuinness, & Donohue, 1995).

Instructional Approach

There are primarily two approaches to literacy instruction: direct instruction and whole language. The following discussion provides a description of the two approaches to instruction, discusses strengths and weaknesses of each approach, and suggests a method for integrating the most advantageous components of the two approaches into a single instructional program.

Direct Instruction. One of the well-recognized approaches to writing

instruction is direct instruction (e.g., Kameenui, et al., 1997; Graham & Harris, 1994). The principles of direct instruction include: (a) explicit and systematic instruction (i.e., the lessons are structured and the targeted skills are taught in a methodical order); (b) instruction in small groups; (c) frequent opportunities to practice the targeted skills; (d) teacher-directed learning; and, (e) minimal practice of errors (e.g., model-prompt-check format of instruction) (e.g., Kameenui & Simmons, 1998; Spiegel, 1992). The model-prompt-check format of instruction is a most-to-least prompting hierarchy. First, the instructor provides instruction by modeling the correct response for several trials. Then, the instructor scaffolds the instruction so that the child is provided with a prompt before the response. Finally, the instructor removes the prompts to assess the child's performance without support. This method of instruction allows the instructor to provide multiple opportunities to practice and simultaneously minimizes the practicing of errors by the child. In general, the primary goal of direct instruction in writing is that children master the basic skills involved in writing, so that they can focus on the construction of the content of their writing (Graham & Harris, 1994).

An example of a direct instruction approach is the University of Oregon Direct Instruction Model which targets the areas of reading, arithmetic, and language. The Direct Instruction Model emphasizes systematic lessons, in which the children work in small groups with a teacher or aide. The main assumptions of the model are that all children can succeed in the program, and children who do not perform well require additional instruction (Kameenui et al., 1997). Project Follow Through was a

federally-funded program designed to evaluate the University of Oregon Direct Instruction Model (Kameenui et al., 1997). The results of the national evaluation recognized that the University of Oregon Direct Instruction model had positive effects on achievement for children who were at risk (i.e., low-income students) participating in the program from kindergarten through third grade. Furthermore, at the end of the third grade, the low-income students were performing near or above the national median (Kameenui et al., 1997).

An advantage of a direct instruction approach to teaching literacy includes the emphasis on multiple opportunities for the children to practice the specific skills in activities guided by the teacher. Another advantage is the systematic organization of the instructional program. Teachers are provided with a scripted format for the presentation of the activities, provision of feedback, and monitoring of children's performance (Kameenui et al., 1997). This facilitates consistency in the instruction not only across children within different groups in a single classroom, but also across teachers in various classrooms. Furthermore, the model/prompt/check method of teaching prevents the children from practicing errors. Finally, an advantage of the direct instruction approach is the supporting evidence (i.e., Project Follow Through) for the effectiveness of the direct instruction approach with children who are at risk for developing functional literacy skills. This has important implications for children who use AAC who are at risk for the development of functional literacy skills.

Although there are many strengths of the direct instruction approach to teaching literacy, there is an important limitation that must be considered. The direct

instruction approach is often criticized for teaching the targeted skills in isolation and neglecting applications of the skills to authentic literacy experiences (e.g., Kameenui et al., 1997). Children are taught specific skills in scripted lessons, but are not provided with authentic literacy experiences to apply the skills they have learned. The effects of such a skill-focused program may result in a lack of generalization to authentic writing tasks. This effect may not be evident in the early stages of literacy development when children are in the primary grades of school, but may appear when children enter intermediate grades and as children begin to develop more advanced reading and writing skills (Traweek & Berninger, 1997).

Whole Language. The second approach to literacy instruction is a whole language approach. A whole language approach to instruction is based on a number of principles, including the beliefs that: (a) learning to read and write is a natural process best acquired through use in naturally occurring contexts; (b) learning should be child-centered; (c) learning should emphasize content and process, not form; (d) children should take ownership and responsibility for their learning (e.g., choosing their own books to read and choosing the topics of their stories); and, (e) children should share their work with their peers (e.g., conferencing with peers) (e.g., Graham & Harris, 1994). Typically, a writing workshop is included as one part of a whole language approach to literacy instruction; in this workshop children are given opportunities to write stories independently (Graham & Harris, 1994). Graves (1983, 1994) and McCormick Calkins (1994) have been strong proponents of the writing workshop, a process-oriented instructional model for teaching writing. The writing

workshop provides children with authentic writing experiences to learn to write (e.g., Atwell, 1987; Graves, 1983, 1984). Some of the principles of the writing workshop are: (a) children select their own topics; (b) children are provided with lengthy and frequent opportunities to write; (c) instruction is child-centered; (d) teachers serve as facilitators for the children's learning (e.g., teachers are expected to recognize teachable moments and provide personalized, individual instruction in specific writing skills via conferences, mini-lessons, modeling, and unscripted dialogue); and, (e) real outcomes are provided for the children's writing (e.g., Calkins, 1994; Graham & Harris, 1994; Graves, 1993, 1994).

The current philosophy stresses that students learn to write by writing, and it is recommended that children be encouraged to write as early as kindergarten (e.g., Atwell, 1987; Calkins, 1994; Vernon & Ferreiro, 1999). Early writing experiences promote development of phonemic awareness and knowledge of the alphabetic principle (e.g., Tangel & Blachman, 1992; Vernon & Ferreiro, 1999). Recently, the whole language approach has been recommended for children with disabilities who use AAC, so that they are able to participate in classroom-based writing activities and develop writing skills (Beukelman & Mirenda, 1998; Chaney, 1990).

In the writing workshop, there is an emphasis on the content of the children's writing rather than correct spelling (Gentry & Gillet, 1993; Calkins, 1994; Graves, 1983, 1994). For young children beginning the writing workshop, expression, not correct spelling, is the primary goal of the writing activities (Calkins, 1994; Graves, 1983, 1994). Some educators have been reluctant to use the writing workshop, since

they feared the use of invented spellings would impede learning correct spellings (Adams, 1990). In fact, it has been suggested that children using invented spellings may know more about the alphabetic system than children using conventional spellings (Clarke, 1988). Furthermore, invented spelling has been used as an indicator of the development of phonemic awareness and alphabetic principles (Rubin & Eberhardt, 1997; Stahl et al., 1998).

Clarke (1988) designed a study to compare two approaches to writing instruction with four classes of first graders: the use of invented spelling and the use of traditional spelling. Half of the first graders included in the study were encouraged to use invented spelling to write stories, and the other half of first graders were encouraged to use traditional spelling. Unfortunately, the study was methodologically flawed because the two groups were not equivalent prior to the start of instruction; the results of the pretests indicated that the children encouraged to use invented spelling initially had significantly higher spelling skills than the children encouraged to use traditional spelling. The author claimed that the results of the study showed that early on, children encouraged to use invented spelling had more spelling errors, but significantly longer stories compared to the children encouraged to use traditional spelling. Furthermore, she suggested that even though it was expected that using traditional spellings would be more time-consuming (i.e., looking up words in a dictionary or waiting for a teacher to ask for a spelling), the children who were encouraged to use traditional spellings tended to stop before the lesson was over and moved to another activity. The children encouraged to use invented spellings

typically continued to write until the end of the lesson. Additionally, the children encouraged to use invented spelling demonstrated greater word analysis skills compared to the children encouraged to use traditional spelling. The researcher had also suggested that children who were encouraged to use invented spelling had significantly greater spelling skills at the conclusion of the study compared to the children encouraged to use traditional spelling.

Clarke (1988) presented an interesting subanalysis in the study. She analyzed the data for a subgroup of children considered low achievers in both the invented spelling group and the traditional spelling group. There were twelve children in each group. The children in the two groups were matched for their reading and spelling abilities prior to instruction. The low achievers in the invented spelling group demonstrated significantly greater gains in spelling and reading at the conclusion of the study compared to the traditional spelling group. This may have important implications for using a whole language approach to writing instruction with children who are at risk for developing literacy skills, including children who use AAC. However, the methodological limitations should be considered. The outcomes may not exclusively be a reflection of the instructional program, but may include confounding factors.

One of the advantages of the writing workshop is that it is a child-directed approach; the teacher adopts the role of a facilitator, the child makes the choices of topics for writing stories, and instruction begins at the level of the child's writing skills (i.e., the teacher uses the child's stories as incidental teaching opportunities to

provide instruction at the child's level of writing) (Calkins, 1994). The instructional program allows children with significantly limited writing experiences a forum to explore writing without pressure for accuracy or correctness (Adams, 1990; Calkins, 1994; Graves, 1994). Fey (1986) also recommends child-oriented approaches for children who are somewhat passive and may not be responsive to trainer-oriented intervention approaches. This may be especially conducive for children who use AAC who may easily become passive in learning situations. Furthermore, the child-oriented approach of the writing workshop may be especially suitable for children who use AAC and lack developmentally appropriate early writing experiences. This approach allows instruction to be customized to an individual child's specific needs for instruction. Furthermore, the child-centered approach provides a very positive and secure environment for risk-taking in early learning. This is particularly important to children with physical and communication disabilities who have very little independence and may develop behaviors of learned helplessness (Beukelman & Mirenda, 1998; Glennen & DeCoste, 1997; Nelson, 1993). Children who use AAC may experience their first attempts at independently creating novel messages through traditional orthography (i.e., the alphabet) in the support of the writing workshop. This will promote the children's sense of authorship. Moreover, development of writing skills may empower children with disabilities in their exploration of language and self-expression, as Graves (1994) has suggested for children without disabilities.

Research has also identified some disadvantages of using this whole language approach to writing instruction. The first disadvantage is that these incidental

methods to teaching writing may not be powerful enough for children who are at risk for developing literacy skills. Children with cognitive or language impairments may require additional repetition in practicing new writing skills or writing strategies (Graham & Harris, 1994; Spiegel, 1992). Similarly, children who use AAC who are at risk for learning literacy skills may require more extensive and explicit instruction in the skills that are necessary for developing functional writing (e.g., letter-sound knowledge, phonemic awareness) (Graham & Harris, 1994). Another disadvantage in using a whole language approach to writing instruction is that effective instruction is dependent on the teacher's ability to recognize teachable moments and provide adequate instruction to meet the individual needs of the children. Furthermore, relying on teachable moments for instruction may lead to inconsistent and incomplete instruction depending on the spontaneous needs that appear during the writing activities. Relying on teachable moments in a whole language approach to instruction may also lead to the overpracticing of errors. This may lead to greater needs for explicit instruction in order to correct established patterns of mistakes (Graham & Harris, 1994). Finally, a disadvantage in using a whole language approach to writing instruction is that the writing workshop is dependent on the construction of oral stories. Children who use AAC who are unable to construct oral stories may have difficulty producing narratives using their communication systems, and will require special adaptations to participate in the whole language approach to writing instruction.

Integrated Approach. Currently, it is generally accepted that an effective

instructional approach should include a balance of both a direct instructional approach and a whole language approach. By combining the two approaches, children are provided with explicit instruction in specific skills in structured activities and instruction in the application of the targeted skills within meaningful literacy experiences (e.g., Adams, 1990; Scott, 2000; Spector, 1995; Stahl et al., 1998). For example, Traweek and Berninger (1997) compared two literacy programs with first-graders: a direct instructional program (i.e., DISTAR) and a whole language program (i.e., Integrated Reading and Writing Program). The DISTAR instructional program was organized into a series of scripted lessons that focus on explicit instruction in phonological awareness skills and letter-sound correspondence. Instruction in the Integrated Reading and Writing Program was structured in the following way: the teacher read stories to the class, the teacher modeled a transcription of a simplified version of the story, and then the children were provided with an opportunity to write their own stories. The results of the study demonstrated that there were no statistically significant differences in the effects of the two programs on reading achievement. There were, however, differences in the children's development of the acquired orthographic-phonologic connections; the children following the direct instructional approach acquired only subword levels (i.e., letters and sounds in isolation) and the children following the integrated instructional approach acquired both subword and whole word levels (i.e., letters and sounds within words). The authors concluded that an instructional program that emphasizes incidental learning may not be sufficient for children to learn the connections between letters and sounds

at the subword level. Equally, the authors suggested that an instructional program that is based on explicit instruction in specific skills might not be adequate for applying the skills to authentic reading and writing experiences. Therefore, an instructional program that facilitates learning of the necessary literacy skills, with applications to authentic literacy experiences may be optimal.

In summary, there are advantages and disadvantages to both direct instruction and whole language approaches to writing instruction. A combination of the two approaches, integrating the strengths of the two approaches to instruction may be the most effective method of writing instruction (e.g., Graham & Harris, 1994; Spiegel, 1992). The integrated approach to instruction should include: (a) explicit, structured instruction in the skills necessary for developing writing skills (e.g., letter-sound correspondence, phonemic awareness); (b) numerous opportunities for the children to actively participate and practice the specific skills; and, (c) extended and frequent opportunities to apply the specific skills in writing experiences.

Adaptations. In addition to the content and approach of the writing instructional program, the unique adaptations for children who use AAC must be considered. The current writing instructional programs for children without disabilities rely on oral productions by the teacher and the children. Children with significant speech impairments will not be able to participate without providing specific adaptations that enable them to participate without using speech. The instructional program may be adapted so that children who use AAC with significant speech impairments may participate by using a communication system. For example,

in a letter-sound correspondence activity, the teacher may produce a sound and ask the child to identify the letter that corresponds using a communication system with the alphabet represented on the system. Special adaptations may also be necessary for children who use AAC with motor impairments. Children unable to write with a pencil may be provided with a communication system with an overlay of the alphabet during writing tasks. The specific adaptations may vary depending on the level of children's motor and speech skills. However, it is critical to consider the adaptations necessary to provide children who use AAC a means to participate in the instructional program.

Research Objective

In light of the need for intervention studies identifying methods of adapting writing instruction for children who use AAC, two single subject multiple probe across subjects research studies were designed to evaluate two writing instructional programs specifically developed for children with significant physical and communication disabilities who use AAC. Both instructional programs were developed to include the components considered best practices of writing instruction: direct instruction in phonemic awareness combined with a writing workshop-type activity to provide writing instruction within writing tasks. The objective of the first study was to determine the effect of the instructional program on the selection of initial letters of words by children who use AAC. The second study was developed

for children who were able to select the initial letters of words, but who were unable to select letters beyond the first ones. Therefore, the goal of the second study was to determine the effect of an instructional program on the selection of final letters of words by children who use AAC.

CHAPTER 2

STUDY 1: THE EFFECT OF AN INSTRUCTIONAL PROGRAM TARGETING SELECTION OF INITIAL LETTER WITH CHILDREN WHO USE AAC

METHOD

Research Design

A single subject multiple probe across subjects experimental research design was used involving three children who used AAC. The independent variable was the writing instructional program, a package including direct instruction in two skills (i.e., letter-sound correspondence and segmentation of initial letter) and a writing workshop-type activity. The dependent variable was the selection of the initial letter when orally presented with single words in a dictation task.

The study involved four phases: baseline, instruction, maintenance, and generalization. During baseline, the children's selection of initial letters was probed periodically. A minimum of three measures were collected for each of the children until a stable baseline was established. Following establishment of a stable baseline for the dependent variable, instruction was implemented with the participants in a sequential manner, beginning with the first participant. While instruction was implemented with the first participant, the other two participants remained in

baseline. Once treatment effects were observed for the first participant, instruction began with the second participant. Similarly, once the second participant demonstrated treatment effects, instruction began with the third participant. While the participants remained in baseline, periodic probes were administered to ensure a stable baseline for the dependent variable, and therefore maintain experimental control.

Maintenance probes were conducted following the completion of instruction for each participant. These probes were used to determine whether the participants were able to maintain the skill (i.e., selection of initial letter) following the completion of instruction. The effectiveness of the instructional program was demonstrated through the comparison of the participants' performances before, during, and after instruction.

Generalization probes were also conducted following the completion of instruction for each participant. The probes were used to determine whether the participants were able to generalize selection of initial letter to a task in which the instructor did not provide the oral model of the word.

Participants

Three children who used AAC were invited to participate in the writing instructional program targeting selection of initial letters. All participants met the following selection criteria: (a) were between the ages of six and twelve; (b) had a

developmental disability (e.g., cerebral palsy); (c) had hearing and vision (with or without correction) within normal limits, as reported by parent, teacher, and/or therapist; (d) had a significant speech impairment (i.e., less than 50% intelligible to an unfamiliar partner, as documented by the transcription of a recorded speech sample by the unfamiliar partner); (e) required the use of an AAC system (i.e., unable to meet daily communication needs through natural speech alone); (f) had adequate language skills to follow simple directions necessary for participating in the instructional program, as measured through a screening of the instructions of the program and formal measures of receptive language, the Peabody Picture Vocabulary Test and the Test for Auditory Comprehension of Language-Revised; (g) had literacy skills at the partial alphabetic level (i.e., able to correctly identify at least 70% of the letters of the alphabet from a field of four when orally presented with the corresponding letter name, may be able to read words by memorizing or guessing from context cues, but unable to decode unfamiliar words) (Ehri, 2000); (h) had writing skills at the earliest stage of development (i.e., unable to segment initial, final, or medial letters of single words); and, (i) had consent from parents or guardians to participate in the project.

Children were recruited through contacting local speech language pathologists and teachers of special education classes. The speech language pathologists and teachers were provided with a description of the project and the inclusion criteria. Once consent was provided for the potential participants, they were then screened by the investigator to determine their eligibility to participate. The three children who participated in the study were Melinda, Haley, and Gary. The following is a

description of demographic information for each of the participants. See Table 1 for a summary of the key demographic information for each participant.

At the time of the study, Melinda was a seven-year-old girl diagnosed with spastic quadriplegic cerebral palsy and cystic fibrosis. She had a congenital amputation of her left hand, had very little voluntary motor control, and demonstrated poor postural control. She used a wheelchair for mobility. Her hearing and vision (with glasses) were reported to be within normal limits by her mother. Melinda lived at home with her older sister, mother, and father. She had a full-time personal care aide during school. Melinda was mainstreamed in a first grade class, however, she was not academically competitive. She had very limited speech skills. She only occasionally vocalized to indicate excitement. She used eye pointing and gestures for yes/no (i.e., a shoulder shrug for yes and a head shake for no). Melinda used a computer-based voice output system (a DeltaTalker) via scanning to communicate; she had used the system for approximately one year. A small switch was mounted to her wheelchair so that she could access the switch at her chin. At the time of the study, she was undergoing assessments for alternate computer-based voice output systems and methods of access. She had eight icons (i.e., line drawings) per page and approximately three pages. The vocabulary of her systems was very limited; the vocabulary included the people in her family and phrases for use during games. The results of her language tests indicated the following scores: the Peabody Picture Vocabulary Test – Standard Score of 77 (6^{th} percentile), and the Test for Auditory Comprehension of Language – Standard Score of 77 (6^{th} percentile). Prior to

Table 1. Demographic Information for Participants in Study 1.

	Melinda	Haley	Gary
Age	7 years	10 years	10 years
Diagnosis	CP	CP	alternating hemiplegia
Speech Intelligibility	occasionally vocalizes	30%	0%
Means of Communication	gestures, eye pointing, DeltaTalker via scanning	gestures, pointing speech approximations, communication boards, DynaVox via scanning	gestures, pointing speech approximations DynaMyte via direct selection
Language Skills: (Standard score)			
PPVT	77	51	40
TACL-R	77	65	65
Literacy Skills:			
Letter name	88%	96%	70%

instruction, Melinda had an accuracy of 88% for letter-name identification; when presented with a sound, she was asked to identify the corresponding letter from a field of four.

Haley was a ten-year-old girl with spastic cerebral palsy. She used a wheelchair and a walker for mobility. Haley lived at home with her four sisters, mother, and father. She was in a special education class for most of her day at school, with approximately five other children with physical and speech impairments. She was included in a second grade class for one class, social studies, a day. Haley used a combination of speech approximations, gestures (e.g., pointing, head nod and shake for yes/no), and communication boards to communicate. She also used a computer-based voice output system (i.e., a DynaVox) via scanning, controlled by a switch activated by short breaths of air. She preferred to use direct selection and often attempted to use direct selection when her spasticity was less severe or the target symbols were within her reach; she had very limited range of motion of her hands and arms. Haley preferred to use speech approximations to communicate and only infrequently used aided AAC systems. The intelligibility of her speech was 30%, as judged by an unfamiliar partner and her utterances were usually about 3-4 words in length (e.g., I want to play). At the time of the study, her communication system had not been programmed. Haley's mother reported previously that she had a vocabulary of approximately 20 words (e.g., toys, games, people, food), represented by line drawings in a schematic organization. The results of her language tests indicated the following scores: the Peabody Picture Vocabulary Test – Standard Score of 51, and

the Test for Auditory Comprehension of Language – Standard Score of 65 (below the first percentile). Prior to instruction, Haley had an accuracy of 96% for letter-name identification; when presented with a sound, she was asked to identify the corresponding letter from a field of four.

Gary was a ten-year-old boy with alternating hemiplegia of childhood. He used a wheelchair for mobility. Gary lived at home with his younger brother, mother, and father. He was in a special education class at school, and attended a daycare program with nondisabled children after school. Gary primarily used vocalizations, some speech approximations, gestures, and a computer-based voice output system (i.e., a DynaMyte) via direct selection with his finger to communicate. Gary preferred to use vocalizations and speech approximations to communicate and infrequently used aided AAC systems. The intelligibility of his speech was 0%. The vocabulary of his communication systems was very limited (e.g., people in his family, needs and wants for school, some phrases for comments). His vocabulary was represented by line drawings and was primarily in a schematic organization. The results of his language tests indicated the following scores: the Peabody Picture Vocabulary Test – Standard Score of 40 (below the first percentile), and the Test for Auditory Comprehension of Language – Standard Score of 65 (below the first percentile). Prior to instruction, Gary had an accuracy of 70% for letter-name identification; when presented with a sound, he was asked to identify the corresponding letter from a field of four.

Materials

An adaptive keyboard (i.e., a DiscoverBoard) was used with a laptop computer in the writing instructional program. The keyboard displayed the letters of the alphabet, including long and short vowels (i.e., depicted with a line above the vowel), for a total of 36 letters arranged in alphabetical order. The letters were lower-case and approximately one inch high. The five target letters were highlighted (i.e., colored yellow) throughout baseline, instruction, maintenance, and generalization. When the keys were depressed, a digitized recording of the corresponding sound, not the letter name was produced to reinforce letter-sound correspondence throughout the instructional program.

Access to the system was customized to suit the motor skills of each participant. Specifically, partner-assisted scanning was used with participants unable to use direct selection. The scanning technique varied across children. In Melinda's case, the instructor pointed to one row and Melinda was provided with a maximum of three seconds to indicate 'yes' to select the row. If she did not indicate 'yes', the instructor moved on to the next row. She was not required to indicate 'no' in order to minimize fatigue. When Melinda indicated 'yes' to select the row, the instructor pointed to each letter within the row until Melinda indicated 'yes' to select a particular letter. In Haley's case, the instructor pointed to one row at a time and Haley indicated 'yes' or 'no' to each row presented. She was given a maximum of three seconds to respond to the choice presented; after three seconds, a 'no response'

was recorded. When Haley indicated 'yes' to select the row, the instructor pointed to each letter within the row. Haley indicated 'yes' or 'no' to each letter presented. Gary used direct selection (with his finger) to access the keyboard. He was given a maximum of ten seconds in order to respond to the item presented; after ten seconds, the item was scored as 'no response'.

Prior to baseline, five target letters for the instructional program were identified. A pool of words beginning with each of the letters of the alphabet (i.e., three exemplars for each letter of the alphabet) was developed (e.g., using dictionaries, children's books). The instructor orally presented a word and asked each participant to identify the initial letter of the word using the adaptive keyboard. The letters that were not correctly identified by any of the participants were placed in a pool of potential letters. Using the sequence of letters for instruction recommended by DISTAR (Engelmann & Bruner, 1978), five letters in the pool that occurred early in the sequence were selected for the instructional program. The five letters were: s, d, c, f, and b.

Materials for the instructional program and probes were developed using a pool of words beginning with the target letters. Approximately four-inch color pictures representing the words were obtained from Boardmaker and CorelDraw. Using a receptive language task, the words were screened with all three participants to ensure that the words were within their receptive vocabulary. Each participant was shown pictures one at a time, representing the words in groups of 20 pictures. The instructor orally labeled each of the pictures in the group for the participant. The

instructor then randomized the order of the pictures and presented the twenty pictures in fields of four. The instructor provided the spoken label of one of the pictures and asked the participant to identify the picture, either through direct selection or partner-assisted scanning. Words that were correctly identified by all three participants were included in the corpus of words for instructional stimuli and probes; words that were not correctly identified by all three participants were excluded from the pool.

The smallest pool of words for one of the target letters was 61; therefore, 61 words were randomly selected for each of the remaining four target letters (i.e., a total of 305 words for the five target letters). The pool of words for each target letter was organized in the following manner. First, eighteen words were randomly selected (without replacement) for stimuli during the instructional sessions. Sixteen words were then randomly selected (without replacement) for use as novel words during the two generalization probes following instruction. Finally, the 27 words remaining in the pool of words were randomly assigned to 28 probes for use during baseline, instruction, and maintenance. Each word did not appear more than once within a single probe, and was used at least eight times (but with a maximum of nine times) across all 28 probes. See Appendix A for a complete list of the 28 probes used in baseline, instruction, and maintenance, the two generalization probes, and the pool of 18 words used as instructional stimuli.

Procedures for the Instructional Program

The independent variable of the study was the writing instructional program (i.e., direct instruction in letter-sound correspondence, direct instruction in segmentation and selection of initial letter, and the writing workshop-type activity). Each session included all three activities. The dependent variable was selection of the initial letter of words presented orally by the instructor, using the adaptive keyboard with the five target letters highlighted.

There were four phases involved in the study: baseline, instruction, maintenance, and generalization. The following is a description of each phase and the procedures and measures involved in each.

Baseline

During each baseline session, a 25-item probe for the dependent variable (i.e., selection of the initial letter from the adaptive keyboard with five target letters highlighted when presented with a word orally in a structured dictation task) was administered. Each probe consisted of five exemplars per target letter, presented in random order. A minimum of three measures of the dependent variable was collected with each participant prior to instruction in order to establish a stable baseline (i.e., a minimum of three points with a slope at or near zero). As was previously discussed in the Research Design section, instruction was implemented with the participants sequentially. Instruction was introduced to the first participant while the other two participants remained in baseline (i.e., in order to establish experimental control). Once treatment effects were observed for the first participant, instruction was implemented with the second participant; the third participation remained in baseline

to maintain experimental control. Once treatment effects were observed with the second participant, instruction was introduced to the third participant.

Treatment effects were defined as the acquisition of selection of the first letter of a word, for the first two target letters. Acquisition of selection of a letter was defined by a criterion of 80% correct (i.e., at least four out of five trials of the target letter correct), over two consecutive probes.

In addition, two other measures were collected during each baseline session to provide supplemental information: letter-sound correspondence and selection of initial letters within a writing task. Specific details of each of the three probes are discussed in the Measures section.

Instruction

Instruction consisted of approximately two to three, 30-45-minute sessions per week. Each instructional session primarily focused on one target letter, but a review of previously targeted letters was also included. The instructional program consisted of four activities: (1) introduction of the target letter, (2) letter-sound correspondence, (3) selection of initial letter, and (4) writing workshop-type activity. See Appendix B for a complete description of the goals and procedures for each activity of the instructional program. The first activity was the introduction of the target letter. The instructor introduced the letter that was the target of the entire session and provided a brief description of the tasks. An activity focusing on letter-sound correspondence was next. The instructor orally presented the sound of the target letter and the participant was asked to select the corresponding letter from an array of 36 letters

(i.e., with the five target letters highlighted) using the adaptive keyboard. The third task was a play activity targeting selection of initial letters. Using the adaptive keyboard, the participant was asked to select the initial letter of a word presented orally by the instructor in a dictation task. A most-to-least prompting hierarchy was used to facilitate errorless learning (Kameenui et al., 1997). The hierarchy of prompts (i.e., full, partial, and no) is described in detail in Appendix B. The final activity was the writing workshop-type activity. The participant was asked to write stories about himself or herself using a sequence of four pictures (i.e., one picture of the participant and three pictures representing vocabulary that began with the target letter of the session) as a visual prompt. For each picture, the instructor orally presented the participant with choices of words for the participant to choose to write. The pictures represented vocabulary that began with the target letter in order to provide opportunities for the child to use the skill of selection of initial letter in writing tasks. Following the completion of the participant's story, the instructor modeled an elaborated story linking the words the participant wrote for each picture. Data were collected for each of the instructional tasks throughout the program to document the participants' progress in each of the tasks. As in the baseline phase, probes targeting the dependent measure (i.e., selection of initial letter when presented with a word orally in a structured dictation task) were administered; the measures were collected every third session (i.e., after two instructional sessions) to document the participants' progress and to determine when to introduce the next target letter. If the participant reached the criterion accuracy for the target letter (i.e., four out of five items correct

for the target letter), a second probe was administered in the next session. If the participant reached the criterion accuracy for the target letter, instruction for the next target letter was initiated in the next session. However, if the participant did not reach the criterion accuracy, instruction in the target letter was repeated for the next two sessions. A complete discussion of the probes used is presented in the Measures section.

Maintenance

Once all five of the target letters were acquired (i.e., an accuracy of 80% on the probes for the dependent measure for two consecutive sessions), instruction was completed and the final maintenance phase was initiated. During maintenance, no instruction was introduced. The probes administered during baseline and instruction phases were given periodically to ensure maintenance of the dependent variable following instruction (i.e., 3 days, 1 week, 2 weeks, and 1 month following instruction).

Generalization

In addition, following instruction, two generalization probes were administered the first and second day after instruction was completed. The generalization probes assessed the ability of the participants to segment and select the target letters in the initial positions of novel words when shown a picture, but without the instructor orally presenting the word. The generalization probes are discussed in the Measures section, also.

Procedural Reliability

Procedural reliability was determined for approximately 25-35% of the instructional sessions to ensure the integrity of the procedures (i.e., 25%-35% of each of the instructional sessions was randomly sampled). First a standard for the procedures was developed. See Appendix B. The instructor was then trained to the developed standard. A trained researcher viewed videotapes of the sessions and coded whether the instructor followed the correct procedures for each step according to the standard described in the instructional manual. Procedural reliability was calculated as the number of correct steps divided by the total number of correct, incorrect, or omitted steps. The procedural reliability across the sessions for the three participants was 95%, with a range of 94%-100%.

Measures

The three measures were selection of the initial letter of words presented orally by the instructor in a dictation-type of task (i.e., the dependent measure), letter-sound correspondence, and selection of initial letter in a writing task. These three measures were collected in each of the probes administered during baseline, instruction, and maintenance.

The first probe administered measured the dependent measure, the selection of initial letter in a dictation-type of task. It consisted of 25 trials, five trials for each of the five target letters. The trials were presented in random order. In each trial, the

participant was asked to select the first letter of a word presented orally, using the adaptive keyboard with an array of 36 letters. The five target letters were highlighted. The instructions were as follows: "I am going to show you some pictures. I am going to tell you what the words are. I want you to show me the letter that is at the beginning of the word that I say. I want you to show me the first letter." "This is _____. What is the first letter in _____."

The probe was administered in every baseline and maintenance session. During the instructional phase, once a criterion of at least 80% for the target letter (i.e., four out of five trials for the target letter in the 25 item probe) was reached for the dependent measure, a second probe was administered in the following session. Then, if the criterion accuracy level (i.e., at least 80% for the target letter) was maintained, the next target letter was introduced. If, however, the criterion accuracy level for the dependent measure was not reached, two additional instructional sessions for the target letter were provided before re-administering a probe.

The second probe measured letter-sound correspondence. It consisted of 25 trials, five trials for each target letter, presented in random order. The participants were asked to identify a letter from a field of four, when presented with the corresponding sound orally. The instructions were as follows: "I am going to show you some letters. I am going to make the sound of a letter and I want you to show me which letter makes the sound." "Show me the letter that makes the sound ____." As with the dependent measure, the measure of letter-sound correspondence was administered every baseline and maintenance session, and after every two

instructional sessions.

The third probe measured the selection of initial letter of a word in a writing task. During baseline and maintenance sessions, the participants were given five pictures representing words that had the five target letters in the initial word position, one picture per target letter (e.g., first, costumes, bunny, sailor, dishes). The participants were asked to choose the order of the pictures in the story and were asked to write about each of the pictures in the sequence chosen, using the adaptive keyboard with an array of 36 letters, with the five target letters highlighted. The instructor orally presented multiple options for target words per picture. The instructions were as follows: "I have five pictures [or three pictures during instruction]. I want you to write a story using the pictures. I want you to choose the order of the pictures for your story. One at a time, I want you to choose a picture and write about it. If you don't know how to spell a word, just sound it out as best as you can." "Here are the pictures for your story." [Instructor labels each picture]. The data were scored for the selection of initial letter only (i.e., the letters following the initial letter were not scored).

For all three measures, the responses were scored as correct if they matched the targets, incorrect if they did not match the targets, and no response if the participant did not respond within a maximum of 15 seconds following the presentation of the item by the instructor. The first response that resulted in speech output was scored. The letters that were depressed accidentally or during a self-correction that resulted in speech output were scored as incorrect.

Inter-rater Reliability

Inter-rater reliability was calculated for approximately 25-35% of the data randomly sampled from each of the probes in baseline, instruction, and maintenance. A second researcher viewed videotapes of the administering of the probes and recoded the data (i.e., the responses were coded as correct, incorrect, or no response). The inter-rater reliability was calculated as a percentage of the number of agreements divided by the total number of agreements and disagreements. The inter-rater reliability was 96% (range 88%-100%) for selection of initial letter, 96% (range 88%-100%) for letter-sound correspondence, 100% for the selection of initial letter in a writing task, across the participants.

Data Analysis

The data for the dependent variable were graphed and analyzed through systematic visual inspection, as recommended for single subject designs (Barlow & Hersen, 1984). The frequencies of the dependent variable were calculated for each probe, during the baseline, instruction, and maintenance phases. The data were presented in graphic form to facilitate visual inspection of changes in level and slope of the data in each of the phases. The session number was graphed on the abscissa and the number of correct responses was graphed on the ordinate. The data for the dependent variable during instruction should be greater than during baseline (i.e., non-overlapping or minimally overlapping) and there should be a rising slope across

sessions (i.e., a learning curve). The percent non-overlapping data (PND) was also calculated (i.e., the number of data points in instruction that are above the level at baseline divided by the total number of data points in instruction).

The data for letter-sound correspondence were graphed for each of the participants across all phases of the study. However, because the letter-sound was not a dependent measure, experimental control was not established and an analysis similar to that of the dependent measure was not possible. The data for the selection of initial letter in the writing tasks was presented in a table format in order to analyze qualitatively. As with the data collected from the letter-sound correspondence probes, the data from the selection of initial letter in writing tasks could not be analyzed because of the lack of experimental control.

RESULTS

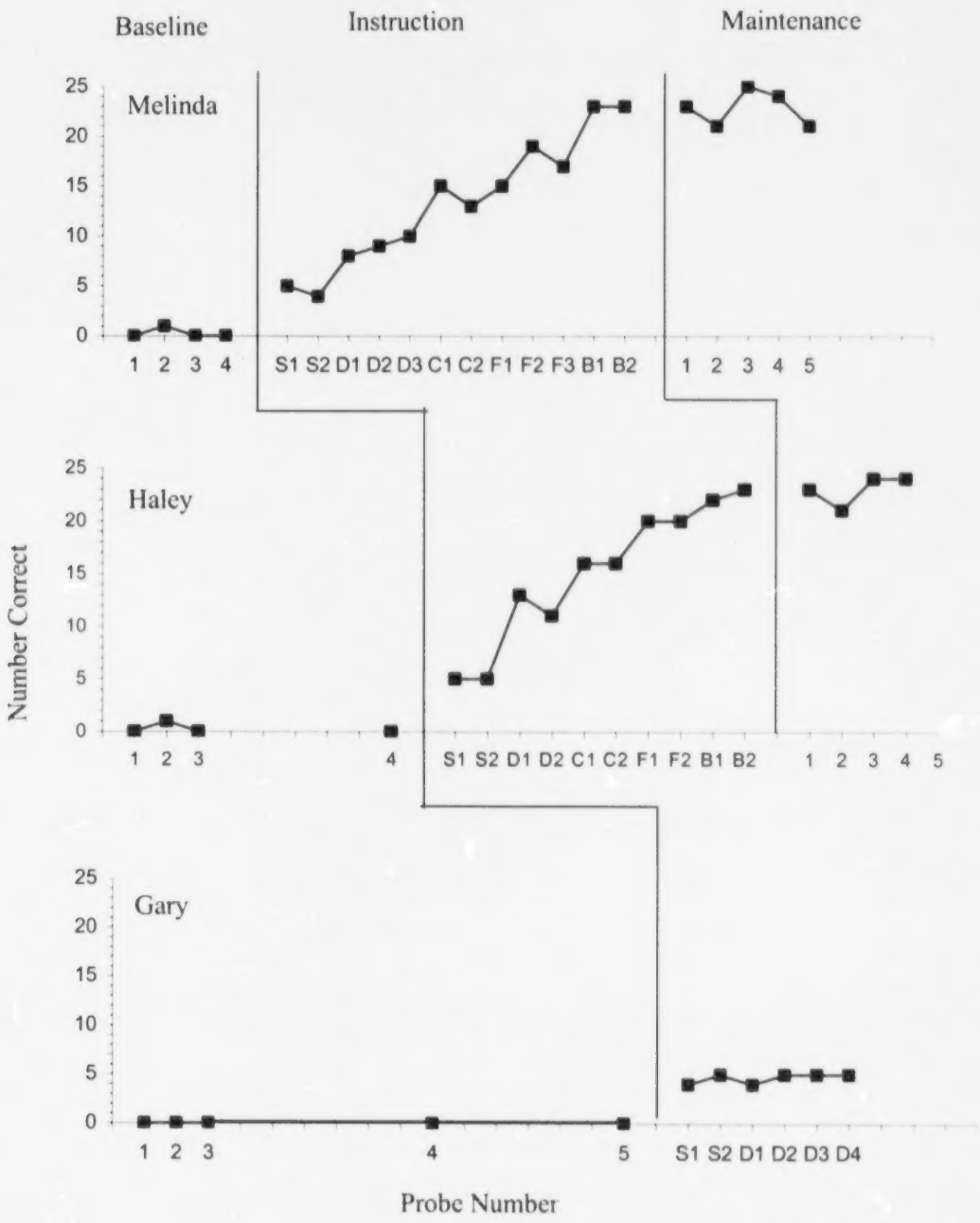
Results for the selection of initial letter in a dictation-type of task (i.e., the dependent variable), letter sound correspondence, and selection of initial letter in a writing task are presented for each of the participants.

Selection of Initial Letter

Figure 1 presents the data for the selection of initial letter by the participants using the adaptive keyboard with an array of 36 letters (i.e., with the five target letters highlighted), when presented orally with single words in a dictation task during baseline, instruction, and maintenance phases of the study.

Both Melinda and Haley were successful in acquiring the selection of initial letter when orally presented with single words in a dictation task, for the five target letters. Melinda required fourteen instructional sessions to acquire the skill for all five target letters (i.e., s, d, c, f, b). She required two instructional sessions to meet the criterion accuracy (i.e., 80%) for s, four instructional sessions for d, two instructional sessions for c, four instructional sessions for f, and two instructional sessions for b. Melinda demonstrated maintenance of the skill for all five target letters three days, one week, two weeks, and one month following the completion of instruction. An additional maintenance probe was administered two months following the completion of instruction, and Melinda was successful in maintaining

Figure 1. Frequency of correct selections of initial letters when orally presented with words in a dictation task during baseline, instruction, and maintenance phases for Melinda, Haley, and Gary.



the selection of initial letter at an accuracy level of 80%. The percent non-overlapping data was 100%.

In addition to the maintenance probes, two generalization probes were administered to determine whether Melinda could segment the initial letters of novel words in response to pictures without the instructor providing an oral model of the words. Melinda achieved an accuracy of 92% on both of the generalization probes. See Table 2 for the results of the generalization probes.

Haley required ten instructional sessions, two sessions per letter, to acquire the selection of initial letters for all five of the target letters. Haley was successful in maintaining an accuracy of at least 80% for the skill three days, one week, two weeks, and one month following the completion of instruction. The percent non-overlapping data was 100%. Haley was also given two generalization probes to determine whether she could segment the initial letters of novel words without the instructor providing an oral model of the words. Haley demonstrated some generalization of the skill (i.e., an accuracy of 40% and 44%), but did not reach criterion for the generalization probes. See Table 2 for the results of the generalization probes.

Gary did not reach criterion for the selection of initial letter, for the five target letters. Gary achieved criterion for the selection of initial letter with the first target letter (i.e., s); however, he selected the letter 's' on the adaptive keyboard as the initial letter for all of the items on the probes. Throughout the eight subsequent instructional sessions focusing on the second target letter (i.e., d) and including a review of the first target letter (i.e., s), Gary demonstrated difficulty distinguishing between the two

Table 2. Frequency of correct selections of initial letters in two generalization tasks without the oral presentation of the words for Melinda and Haley.

	Generalization Probe 1	Generalization Probe 2
Melinda	23 (92%)	23 (92%)
Haley	10 (40%)	11 (44%)

target letters. He selected the letter 's' for almost all of the items during the instructional activities and probes. See Table 3 for a summary of the number of times Gary selected 's' for the 25-item probes. The instructional program in initial letter selection was discontinued with Gary following ten instructional sessions and six probes. Instead, instruction was modified to focus on letter-sound correspondence. See the Discussion section.

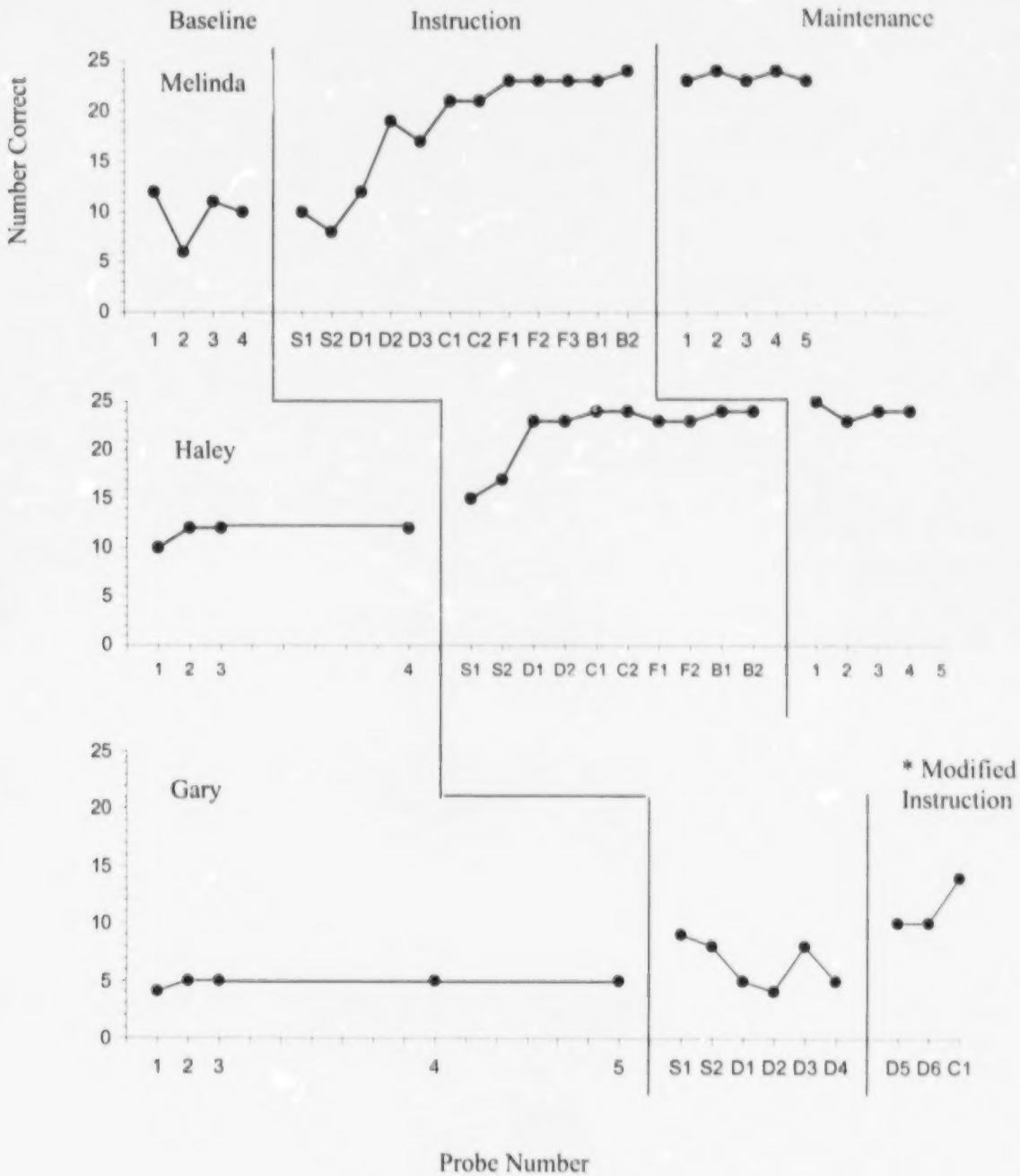
Letter-Sound Correspondence

Knowledge of letter-sound correspondence is required for the acquisition of selection of initial letter; therefore, letter-sound correspondence was included as part of the instructional activities, as well as the probes. Figure 2 presents the data for letter-sound correspondence probes during baseline, instruction, and maintenance

Table 3. Error analysis for the selection of initial letter probes administered during instruction for Gary. Each 25-item probe consisted of five trials targeting each of the target letters (i.e., s, d, c, f, and b) presented in a random order.

	Probe					
	S1	S2	D1	D2	D3	D4
'S' responses	22	25	23	25	25	25
'D' responses	0	0	0	0	0	0
'C' responses	0	0	0	0	0	0
'F' responses	0	0	0	0	0	0
'B' responses	0	0	0	0	0	0
'Other' responses	3	0	2	0	0	0

Figure 2. Frequency of correct selections of letter-sound correspondence during baseline, instruction, and maintenance phases for the Melinda, Haley, and Gary.



phases of the study for Melinda, Haley, and Gary.

Melinda was successful in acquiring letter-sound correspondence for the five target letters in fourteen instructional sessions. Furthermore, she was able to maintain the skill three days, one week, two weeks, one month, and two months following the completion of instruction.

Haley reached criterion (i.e., 80%) for letter-sound correspondence for the five target letters in ten instructional sessions. She was successful in maintaining letter-sound correspondence for the target letters three days, one week, two weeks, and one month following the completion of instruction.

Similarly to the selection of initial letter skill, Gary demonstrated difficulty with the acquisition of letter-sound correspondence for the five target letters. Gary reached criterion for letter-sound correspondence for the first target letter (i.e., s). As with the selection of initial letter tasks, he frequently overgeneralized the selection of 's' during the letter-sound correspondence instructional tasks and probes. The results of the probes suggested that he had difficulty distinguishing the target letters at the level of letter-sound correspondence. See Table 4 for the error analysis.

Selection of Initial Letter in a Writing Task

Table 5 presents the data for the probes targeting selection of initial letter in a writing task for Melinda, Haley, and Gary during baseline and maintenance. During baseline and maintenance phases of the study, the participants were provided with

Table 4. Error analysis for the selection of letter-sound correspondence probes administered during instruction for Gary. Each 25-item probe consisted of five trials targeting each of the target letters (i.e., s, d, c, f, and b) presented in a random order.

	Probe					
	S1	S2	D1	D2	D3	D4
'S' responses	16	18	11	15	17	14
'D' responses	2	1	6	3	2	2
'C' responses	3	2	2	3	2	2
'F' responses	3	1	6	2	3	4
'B' responses	1	3	0	2	1	3

five pictures representing vocabulary with the target letters in the initial position (i.e., one for each target letter). All three participants had a level of accuracy of 0% throughout baseline. Melinda and Haley were successful in achieving an accuracy of at least 80%, with a range of 80%-100% throughout the maintenance phase.

Table 5. Percentage of correct selections of initial letters in writing tasks for Melinda, Haley, and Gary during baseline and maintenance.

Session	Melinda Initial Letter	Haley Initial Letter	Gary Initial Letter
Baseline 1	0%	0%	0%
Baseline 2	0%	0%	0%
Baseline 3	0%	0%	0%
Baseline 4	0%	0%	0%
Baseline 5	---	---	0%
Maintenance 1	80%	100%	---
Maintenance 2	100%	80%	---
Maintenance 3	80%	80%	---
Maintenance 4	80%	100%	---
Maintenance 5	80%	---	---

Gary did not complete the instructional program, therefore there are no data reported in Table 5 for the maintenance phase. Appendix C presents a sample of the data for the selection of initial letter during a writing task for Melinda and Haley during baseline and maintenance, and Gary during baseline.

DISCUSSION

Acquisition and Maintenance

The results of the Study 1 demonstrated that the instructional program targeting the selection of initial letter was effective for two of the three children participating in the study. Melinda was successful in acquiring the phonemic awareness skill, selection of initial letters, for the five target letters. Furthermore, she was able to maintain use of the target skill two months following the completion of instruction. Haley also acquired the target skill and maintained use of the target skill one month following instruction. Melinda and Haley's acquisition and maintenance of the selection of initial letters supports the research with individuals with severe congenital speech impairments who also demonstrated the ability to acquire phonemic awareness skills despite limited speech skills (e.g., Dahlgren Sandberg & Hjelmquist, 1996; Foley & Pollatsek, 1999). These findings support the suggestions that children who are at risk for developing functional literacy skills may benefit from explicit and systematic instruction in the skills (e.g., Graham & Harris, 1994; Kameenui et al., 1997).

The effectiveness of the program may be attributed to several aspects of the design of the program. The children were provided with frequent opportunities to practice the target skills in each instructional session. The most-to-least prompting hierarchy facilitated early success for the children and minimized the practicing of

errors during learning. The lessons were structured to target only one letter at a time and instruction continued to mastery; furthermore, each lesson included a review of previously mastered target letters. Finally, the 'game' format of the instructional tasks may also have contributed to the effectiveness of the program.

Melinda and Haley were also able to apply the use of the target skill to writing tasks. Because the instructional program was delivered as a package of skills (i.e., a direct instruction approach to teaching letter-sound correspondence and phonemic awareness, and a whole language approach to teaching the applications of the skills to writing experiences), it is not possible to conclude whether they would have performed as well with only structured activities without the whole language component of the instruction. It has been suggested that the whole language approach to instruction is necessary for children to learn the applications of the skills beyond the subword level (e.g., Traweek & Berninger, 1997). However, the only conclusions that can be made from the performances of Melinda and Haley are that the instructional program which included both a direct instructional approach and a whole language approach was successful in teaching the two participants to apply the target skills to writing tasks.

Gary demonstrated difficulty in acquiring the selection of initial letter and letter-sound correspondence. Although the program was discontinued with Gary, he participated in some informal instruction to try and determine the source of his difficulties. The participation in both activities, letter-sound correspondence and selection of initial letter, in addition to the writing workshop-type activity, may have

been too cognitively demanding for Gary. His personal care aide suggested that the sessions may have been too long and exhausting for him. A simplified instructional program was developed for Gary, in which the sessions were shortened to approximately 15 minutes and only the letter-sound correspondence activity was addressed. Furthermore, to keep his attention focused on the activity, cards with the target letters, s, d, c, and f, in larger print were used, and the instructor presented the letters in a field of four and rearranged the large cards after each item. The instructor began each session with at least five models in order to facilitate errorless learning. The same correction procedure described in the instructional program was used with Gary in these modified sessions focusing on letter-sound correspondence. After six fifteen-minute sessions, Gary had acquired letter-sound correspondence for the target letters, s, d, and c, with an accuracy of at least 80%. His success with the modified sessions suggests that the instructional program focusing on selection of initial letters, letter-sound correspondence, and selection of initial letters of words in writing tasks may have been too cognitively demanding for Gary. He may have required mastering one skill at a time instead of working on all three simultaneously. Letter-sound correspondence was chosen as the focus of the modified instructional program because letter-sound correspondence is a prerequisite for the selection of initial letters of words. Proponents of a direct instruction approach would suggest that a child having difficulty in the acquisition of the target skills may require additional explicit instruction (e.g., additional opportunities within a lesson, or additional lessons focusing on one target) (e.g., Graham & Harris, 1994; Kameenui et al., 1997). When

the demands of the instructional sessions were minimized (i.e., instruction was limited to letter-sound correspondence), Gary was able to reach an accuracy level of 80% for three of the target letters for letter-sound correspondence. With additional time, Gary may have been successful in acquiring the selection of initial letters after he mastered letter-sound correspondence for the target letters.

The instructional program and the modified instructional program specially designed for Gary were similar to some of the direct instruction literacy programs available for children without disabilities (e.g., structured lessons, scripted instructions and feedback, multiple opportunities to practice the target skills).

Generalization

Melinda was successful in generalizing the use of the target skill (i.e., selection of initial letter) when not provided with an oral model of the word by the instructor. This is consistent with the literature that suggests some individuals who use AAC not only have the potential to learn early literacy skills, but they also may potentially become independent writers (e.g., Koppenhaver, Evans, &Yoder, 1991). Haley demonstrated some generalization of the target skill, but only reached an accuracy of 44%. The results of the generalization probes would suggest that Haley may have required additional explicit instruction in the selection of initial letters without an oral model of the word from the instructor. Her performance may have improved if there was a component included in the instructional program which

provided explicit instruction and practice in selecting the initial letters of words independently.

CHAPTER 3

STUDY 2: THE EFFECT OF AN INSTRUCTIONAL PROGRAM TARGETING SELECTION OF FINAL LETTER WITH CHILDREN WHO USE AAC

METHOD

Research Design

A single subject multiple probe across subjects experimental research design was implemented for two children who used AAC. The independent variable was the writing instructional program, which included direct instruction in the segmentation and selection of initial letter, direct instruction in the segmentation and selection of final letter, and a writing workshop-type activity. The dependent variable was the selection of the final letter of single words when presented orally with single words in a dictation task.

The study involved four phases: baseline, instruction, maintenance, and generalization. As described in Study 1, a stable baseline was established for each participant. Instruction was then introduced to the first participant, while the second participant remained in baseline. Periodic probes for the dependent variable were administered while the second participant remained in baseline. Once treatment effects were evident for the first participant (i.e., a criterion of 80% for two

consecutive probes, for the first two target letters), instruction was implemented with the second participant.

Once the participants reached a criterion of 80% accuracy for all five target letters, maintenance probes were conducted (i.e., 3 days, one week, two weeks, and one month following the completion of instruction). These probes were administered as a measure of the participants' ability to maintain the selection of final letter at an accuracy level of at least 80% without ongoing instruction. As in Study 1, a comparison of the participants' performances before, during, and after instruction served as an indication of the effectiveness of the instructional program.

Generalization probes were also conducted following the completion of instruction. The generalization probes were used to determine the ability of the participants to select the initial and final letters of words, without the oral model provided by the instructor.

Participants

Two children who use AAC were invited to participate in the writing instructional program targeting selection of final letters. All participants met the following selection criteria: (a) were between the ages of six and twelve; (b) had a developmental disability (e.g., cerebral palsy); (c) had hearing and vision (with or without correction) within normal limits, as reported by parent, teacher, and/or therapist; (d) had a significant speech impairment (i.e., less than 50% intelligible to an

unfamiliar partner, as documented by the transcription of a recorded speech sample); (e) required the use of an AAC system (i.e., unable to meet daily communication needs through natural speech alone); (f) had adequate language skills to follow simple directions necessary for participating in the instructional program, as measured through a screening of the instructions of the program and formal measures of language, the Peabody Picture Vocabulary Test and the Test for Auditory Comprehension of Language-Revised; (g) had literacy skills at the partial alphabetic level (i.e., able to correctly identify at least 70% of the letters of the alphabet from a field of four when orally presented with the corresponding letter name, may be able to read words by memorizing or guessing from context cues, but unable to decode unfamiliar words) (Ehri, 2000); (h) were able to identify at least 80% of the letters of the alphabet when presented orally with corresponding sounds; (i) were able to select at least 75% of the letters of the alphabet in the initial position of words; (j) were able to segment final or medial letters of single words with less than 5% accuracy; and, (i) had consent from parents or guardians to participate in the project.

The same procedures for the recruitment of participants in Study 1 were followed in Study 2. Local speech language pathologists and teachers were provided with a description of the project and the criteria for inclusion. After obtaining consent, potential participants were screened by the investigator to determine their eligibility to participate. The two children who were recruited for the study were Janie and Tommy. The following is a description of important demographic information for the participants. Table 6 presents the a summary of the demographic information.

Table 6. Demographic Information for Participants in Study 2.

	Janie	Tommy
Age	10 years	7 years
Diagnosis	unknown	CP, microcephaly
Speech Intelligibility	10%	30%
Means of Communication	gestures, pointing signs, speech approximations, DeltaTalker and DynaMyte via direct selection	gestures, pointing speech approximations, communication boards
Language Skills: (Standard score)		
PPVT	65	45
TACL-R	74	65
Literacy Skills:		
Letter name	100%	100%
Letter-sound correspondence	100%	94%

Janie was a ten-year-old girl with a speech and physical developmental disorder of unknown etiology. She was born with severe motor impairments involving her oral musculature and limbs. She learned to use a walker at the age of two. At the time of the study, Janie was ambulatory, but required some assistance. Janie had two older sisters, and lived at home with her mother and father. She was mainstreamed in a third grade class, attended daycare after school, and had a full-time personal care aide. Janie used a combination of gestures, pointing, signs, and speech approximations to communicate. There were no formal measures of the size of her vocabulary via signs and spoken words. Her mother estimated a vocabulary of approximately 50 signs. There was no written documentation of the size of Janie's spoken vocabulary. Janie also used two computer-based voice output systems (i.e., a DynaMyte and a DeltaTalker) to communicate. She had first received the DeltaTalker approximately two years prior to the study. At the time of the study, she had recently received the DynaMyte. She used the systems to combine single words (e.g., names of family members, friends, and therapists, classes in school, and places she liked to visit) and communicate preprogrammed phrases. She had approximately 50 words represented by line drawings and organized both schematically and taxonomically. She preferred to use speech approximations at home with her family, but used her aided AAC systems at school with less familiar partners. Her speech intelligibility was 10%. The results of her language tests were as follows: the Peabody Picture Vocabulary Test – Standard Score of 65 (1st percentile), and the Test for Auditory Comprehension of Language – Standard Score of 47 (below first

percentile). Janie had an accuracy of 100% for letter-name identification and an accuracy of 100% for letter-sound correspondence.

Tommy was a seven-year-old boy with cerebral palsy and microcephaly. At the time of the study, he was ambulatory, but required assistance with maintaining balance during walking, sitting, and climbing steps. Tommy lived with at home with his mother, father, and twin sister. He was in a life-skills classroom with children with a wide range of disabilities, and had a full-time personal care aide. Tommy used a combination of gestures, speech approximations, and communication boards to communicate. At the time of the study, Tommy's mother was interested in finding a computer-based voice output systems to facilitate Tommy's communication. The vocabulary for his communication boards had not been updated since preschool; the systems were primarily used for choice-making. He had approximately seven pages with four or five vocabulary items per page. The vocabulary was represented by line drawings and was organized taxonomically. His speech intelligibility was 30%. The results of his language tests were as follows: the Peabody Picture Vocabulary Test – Standard Score of 45 (below first percentile), and the Test for Auditory Comprehension of Language – Standard Score of 65 (below first percentile). Tommy had an accuracy of 100% for letter-name identification and an accuracy of 94% for letter-sound correspondence.

Materials

An adaptive keyboard (i.e., a DiscoverBoard) was used in the instructional program. Refer to the Materials section for Study 1 for a complete description of the keyboard.

As in Study 1, five target letters for the instructional program were identified prior to the start of the study. A pool of words ending with the each of the letters of the alphabet (i.e., three exemplars for each letter of the alphabet) was developed. Each participant was asked to identify the final letter of each of the words in the pool, when the instructor presented the words orally. The letters that were not correctly identified by all three participants were included in a pool of potential letters. As in Study 1, the DISTAR sequence of letters (Engelmann & Bruner, 1978) was used to select the five target letters for the instructional program; the five letters in the pool that occurred early in the sequence were selected for the instructional program (i.e., p, n, r, l, d).

Materials for the instructional program and probes were developed using a pool of words ending with the target letters. A second pool of words was developed for the probes for selection of initial letters. As in Study 1, the pictures used in the instructional program were obtained from Boardmaker and CorelDraw. Each of the words was screened with the participants using the same procedures outlined in Study 1. The result was 37 words for each of the five target letters (i.e., a total of 185 words). First, twelve words were randomly selected (without replacement) for stimuli

during the instructional sessions. Ten words were then randomly selected (without replacement) for use as novel words during the two generalization probes following instruction. The 25 words remaining in the pool of words were randomly assigned to 20 probes. Each word did not appear more than once within a single probe, and was used at least eight times (but with a maximum of nine times) across all 20 probes. See Appendix D for a complete list of the 20 probes used in baseline, instruction, and maintenance, the two generalization probes, and the pool of 12 words used as instructional stimuli.

Procedures for the Instructional Program

The independent variable of the study was the writing instructional program, a package including direct instruction in segmentation and selection of final letter, direct instruction in segmentation and selection of initial and final letters, and the writing workshop-type activity). All of the activities were included in each session. The dependent variable was selection of the final letter of a word presented orally by the instructor, using the adaptive keyboard with the five target letters highlighted.

There were four phases involved in the study: baseline, instruction, maintenance, and generalization. The following is a description of each phase and the procedures and measures involved in each.

Baseline

In each baseline session, the instructor administered a 25-item probe for the

selection of the final letter of words. The instructor presented each word orally in a structured dictation task. The participants used an adaptive keyboard with an array of 36 letters, with the five target letters highlighted. A minimum of three measures of the dependent variable were collected with the two participants in order to establish a stable baseline (i.e., a minimum of three points with a slope at or near zero). As was described in the Research Design section, instruction was implemented with the first participant until treatment effects were observed. Periodic probes for the selection of the final letter were administered to the second participant remaining in baseline to maintain experimental control. Once treatment effects were observed for the first participant, instruction was introduced to the second participant.

Two other measures were collected during each baseline session to provide supplemental information: selection of initial letters within a structured dictation task and selection of both initial and final letters within a writing task. Specific details of each of the three probes are discussed in the Measures section.

Instruction

Each instructional session was approximately 30-45 minutes in length. Participants received two to three sessions per week. Each instructional session primarily focused on one target letter, and included a review of previously targeted letters. The instructional program consisted of four activities: (1) introduction of the target letter, (2) selection of final letter, (3) selection of initial and final letters, (4) selection of initial and final letters in a writing task. See Appendix E for a complete description of the goals and procedures for each activity of the instructional program.

The instructor introduced the letter that was the target of the entire session and provided a brief description of the tasks in the first instructional activity. A play activity focusing on selection of final letters followed. The instructor orally presented a word and asked the participant to select the final letter of the word using the adaptive keyboard with an array of 36 letters, with the five target letters highlighted. The same correction procedures described for Study 1 were used in Study 2. The next task was a play activity targeting selection of initial and final letters. Using the adaptive keyboard, the participants were asked to select the initial letter of a word and then the final letter of the same word, when presented with words orally by the instructor in a dictation task. The same prompting hierarchy (i.e., full, partial, and no) used in Study 1 was also incorporated for this activity. The fourth activity was the writing workshop-type activity. The participant was asked to write stories about themselves using a sequence of four pictures (i.e., one picture of the participant and three pictures representing words that ended with the target letter of the session) as a visual prompt. The pictures represented vocabulary that ended with the target letter in order to provide opportunities for the child to use the skill of selection of initial and final letters in writing experiences.

As in Study 1, data were collected for each of the instructional tasks throughout the program to document the participants' progress in the selection of final letters, initial letters, and the writing workshop-type activity. As in the baseline phase, probes targeting the dependent measure (i.e., selection of final letter when presented with a word orally in a structured dictation task from an adaptive keyboard

of 36 letters, with the five target letters highlighted) were administered after every two instructional sessions. A complete discussion of the probes used in the instruction phase is presented in the Measures section.

Maintenance

When the participant selected all five of the target letters in final positions of words with an accuracy of at least 80% over two consecutive sessions, instruction was complete. The probes administered were given 3 days, 1 week, 2 weeks, and 1 month following instruction in order to ensure maintenance of the dependent variable.

Generalization

As described in Study 1, two generalization probes were administered following the completion of instruction and before the first maintenance probe. The generalization probes assessed the ability of the participants to select the initial and final letters of novel words when shown a picture, but without the instructor providing the oral model of the word. The generalization probes are discussed in the Measures section.

Procedural Reliability

As previously described for Study 1, procedural reliability was determined for approximately 25-35% of the data from each instructional session to ensure the integrity of the procedures. The instructor was trained to the developed standard for the procedures. See Appendix E. A second researcher was trained and viewed videotapes of the sessions to code whether the instructor followed the correct procedures for each step according to the standard. The procedural reliability was

calculated as the number of correct steps divided by the total number of correct, incorrect, or omitted steps.

The procedural reliability for the instructional sessions was: 96%, with a range of 88%-100%.

Measures

The three measures were the selection of the final letter of a word presented orally by the instructor (i.e., the dependent measure), selection of initial letter, and selection of initial and final letters in a writing task. The three measures were administered during baseline, instruction, and maintenance.

The first probe was the selection of the final letter, and it consisted of 25 trials, five trials for each of the five target letters, presented in random order. In each trial, the participant was asked to use the adaptive keyboard of 36 letters with the five target letters highlighted to select the final letter of a word presented orally by the instructor. The instructions provided were as follows: "I am going to show you some pictures. I am going to tell you what the words are. I want you to show me the letter that is at the end of the word that I say. I want you to find the last letter." "This is _____. What is the last letter in _____."

The schedule and procedures for the administering of the probes during the instruction phase of the study was identical to those described in the Study 1. The probe was administered once every third session (i.e., after two instructional sessions)

during the instructional phase of the study, in order to continuously assess progress, as well as to determine when to introduce the next target letter. Once an accuracy of at least 80% for selecting the target letter in the final positions of words was reached, a second probe was administered in the following session. If the criterion of at least 80% accuracy was maintained, the next target letter was introduced. Two additional instructional sessions for the target letter were provided before re-administering a probe, if the criterion accuracy level was not maintained.

The next probe was the selection of initial letters within a dictation task. Fifteen trials were administered (i.e., one trial for each of the letters: b, c, d, f, g, h, j, l, m, n, p, r, s, t, w). The fifteen letters used in each of the probes were selected as a sample of the letters of the alphabet, to ensure the participants were able to maintain the selection of initial letter skill as they acquired selection of final letter. The instructions for the probes were as follows: "I am going to show you some pictures. I am going to tell you what the words are. I want you to show me the letter that is at the beginning of the word that I say. I want you to find the first letter." "This is _____. What is the first letter in _____." The measure of letter-sound correspondence was administered every baseline and maintenance session, and after every two instructional sessions.

For the final probe, the participants were given five pictures representing words that ended with the target letters, one picture per target letter (e.g., lid, snip, door, ball, dolphin). As in Study 1, the participants were asked to choose the order of the pictures and were asked to write about each of the pictures in a sequence. The

instructions were as follows: "I have five pictures. I want you to write a story using the pictures. I want you to choose the order of the pictures for your story. One at a time, I want you to choose a picture and write about it. If you don't know how to spell a word, just sound it out as best as you can. I want you to write as many letters as you can for each word." "Here are the pictures for your story." [Instructor labels each picture]

As in Study 1, the instructor orally presented multiple target words per picture. Once the participants completed each of the pictures, the responses were scored in the same manner as the responses for the other two measures.

The participants' responses were scored for each probe task as correct if they matched the target, incorrect if they did not match the target, and no response if the participant did not respond within 15 seconds following the instructor's oral model. And, as defined in Study 1, the first response that resulted in speech output was scored. Letters that were depressed accidentally or for self-correction that resulted in speech output were scored as incorrect.

Inter-rater Reliability

As described for Study 2, inter-rater reliability was calculated for approximately 25-35% of the data from the probes for each session in baseline, instruction, and maintenance. The data selected for reliability in each session were randomly sampled. A second researcher was trained in the coding of the responses, viewed videotapes of the sessions, and recoded the data (i.e., the responses were coded as correct, incorrect, or no response). The inter-rater reliability was calculated

as a percentage of the number of agreements divided by the total number of agreements and disagreements. The inter-rater reliability was 100% for selection of final letter, 96% (range 90%-100%) for initial letter, and 96% (range 90%-100%) for the selection of initial and final letter in a writing task, across the participants.

Data Analysis

The data for the dependent variable were presented in graphic form to facilitate visual inspection of changes in level and slope of the data in each of the phases (Barlow & Hersen, 1984). The frequencies of the dependent variable were calculated for each probe and graphed on the ordinate. The session number was graphed on the abscissa. As described in Study 1, the data for the dependent variable during instruction should be greater than during baseline (i.e., non-overlapping or minimally overlapping) and there should be a rising slope across sessions (i.e., a learning curve). The percent non-overlapping data (PND) was also calculated (i.e., the number of data points in instruction that are above the level at baseline divided by the total number of data points in instruction).

RESULTS

Results for the selection of final letter in a dictation task, selection of initial letter in a dictation task, and selection of initial and final letter in a writing task are presented for each of the participants.

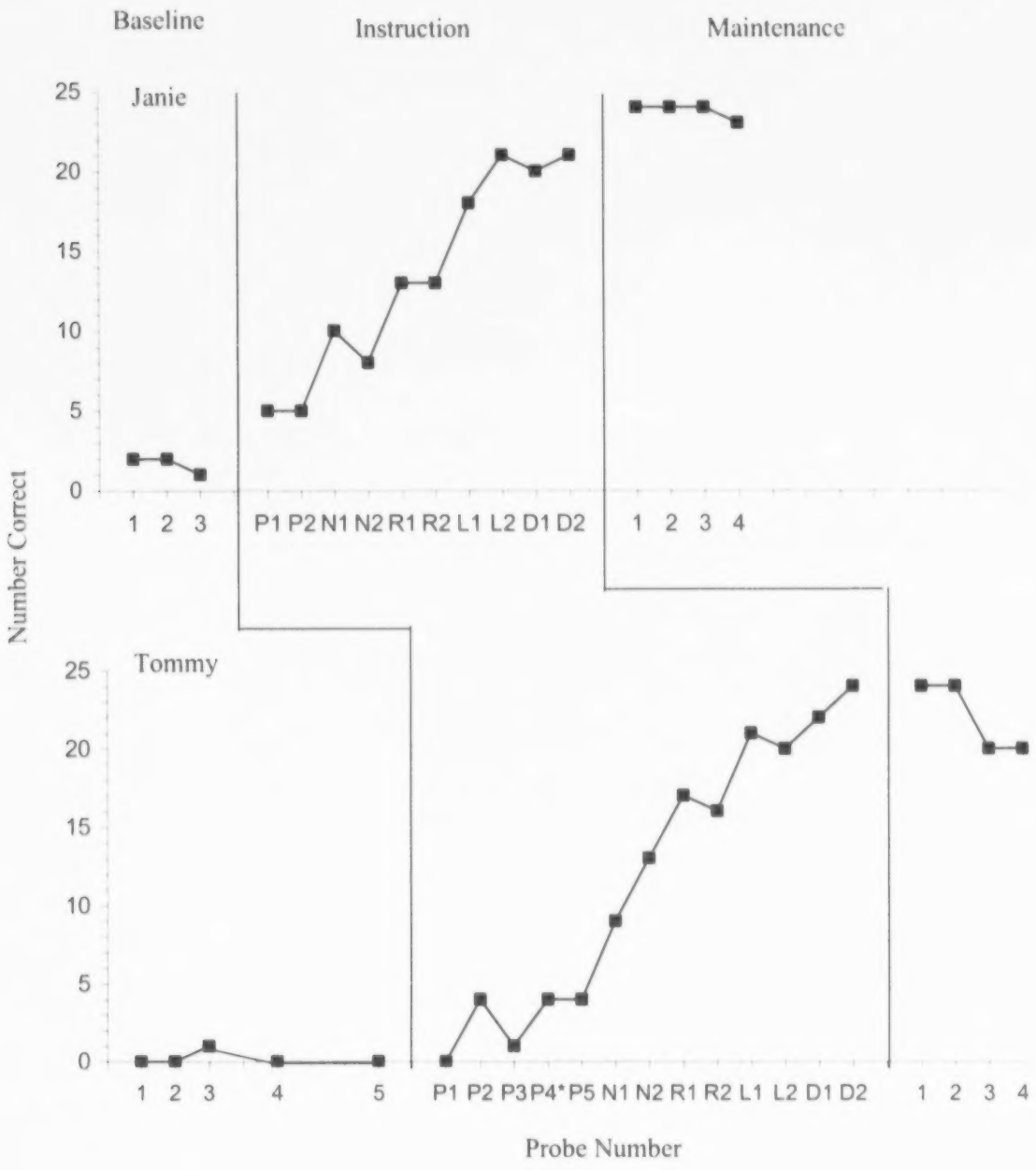
Selection of Final Letter

Figure 3 presents the data from the probes targeting the selection of final letter by the participants using the adaptive keyboard, with the five target letters highlighted, when presented orally with single words in a dictation task during baseline, instruction, and maintenance phases of the study.

Janie acquired the selection of final letter when orally presented with single words in a dictation task, using the adaptive keyboard, with an array of 36 letters, with the five target letters highlighted. She reached and maintained a criterion of at least 80% accuracy. Janie required ten instructional sessions to acquire the skill for all five target letters (i.e., p, n, r, l, d). She demonstrated maintenance of the skill one month following the completion of instruction. The percent non-overlapping data was 100%.

Tommy also acquired and maintained the selection of final letter when orally presented with words in a dictation task, with an array of 36 letters, with the five target letters highlighted; he reached an accuracy level of at least 80%. He

Figure 3. Frequency of correct selections of final letters when orally presented with words in a dictation task during baseline, instruction, and maintenance phases for Janie and Tommy.



required 16 instructional sessions to acquire the selection of final letters. He required eight instructional sessions to acquire the selection of the first target letter (i.e., p), in the final position of words. Once he reached the criterion accuracy (i.e., 80%) for the target letter, he required only two sessions of instruction for each of the remaining target letters. Tommy had initially demonstrated difficulty in distinguishing between the concepts of 'first' and 'last' during the instructional program activities. Therefore, after six sessions of instruction and three sessions of probes, an additional visual prompt was included in the instructional program for Tommy. During the two instructional activities, "Selection of Final Letter" and "Selection of Initial and Final Letter", the instructor simultaneously presented each word orally and showed Tommy the written word with the target letter(s) covered as a visual prompt. During the probes for selection of initial and final letters of words, Tommy was only presented with the word orally and no additional prompts were provided. Tommy also demonstrated success in the maintenance of selection of final letter when orally presented with words in a dictation task three days, one week, two weeks, and one month following the completion of instruction. The percent non-overlapping data was 85%.

In addition to the maintenance probes, two generalization probes were administered to determine whether Janie could segment the initial and final letters of novel words without the instructor providing an oral model of the words. She achieved an accuracy of 24% and 28% on the generalization probes for final letter

selection and 92% on both for initial letter selection. See Table 7 for the results of the generalization probes for Janie. Tommy reached a criterion of 32% on the two generalization probes for final letter selection and 96% and 100% for initial letter selection that were administered following instruction. See Table 7 for the results of the generalization probes for Tommy.

Table 7. Frequency of correct selections of initial and final letters for Janie and Tommy in generalization tasks without presentation of an oral model by the instructor.

	Generalization Probe 1		Generalization Probe 2	
	Initial	Final	Initial	Final
Janie	23 (92%)	6 (24%)	23 (92%)	7 (28%)
Tommy	24 (96%)	8 (32%)	25 (100%)	8 (32%)

Selection of Initial Letter

Although the selection of initial letter was not the primary target skill of the instructional program, it was included as part of the instructional activities to provide

the participants with a review of previously acquired phonemic awareness skills critical for the development of early writing. Selection of initial letter was also included in the instructional program in order to provide the participants with instruction in writing both initial and final letters of single words and therefore, facilitate development of their writing skills. The selection of initial letter when orally presented with words in a dictation task was included in the measures for baseline, instruction, and maintenance in order to determine whether the participants maintained the skill throughout the program. Figure 4 presents the data for selection of initial letter during baseline, instruction, and maintenance phases of the study.

Both Janie and Tommy were successful in maintaining their skills in the selection of initial letter when orally presented with single words in a dictation task, at an accuracy level of at least 80%.

Selection of Initial and Final Letters in a Writing Task

Table 8 presents the data for the selection of final letter in a writing task for Janie and Tommy during baseline and maintenance. They were provided with five pictures representing vocabulary with the target letters in the final position (i.e., one for each target letter) during baseline and maintenance phases of the project. During baseline, Janie had 0% accuracy for the selection of final letters and at least 80% accuracy (i.e., with a range of 80%-100%) for the selection of initial letters. During maintenance, Janie selected both initial and final letters with at least 80% accuracy

Figure 4. Frequency of correct selections of initial letters when orally presented with words in a dictation task during baseline, instruction, and maintenance phases for Janie and Tommy.

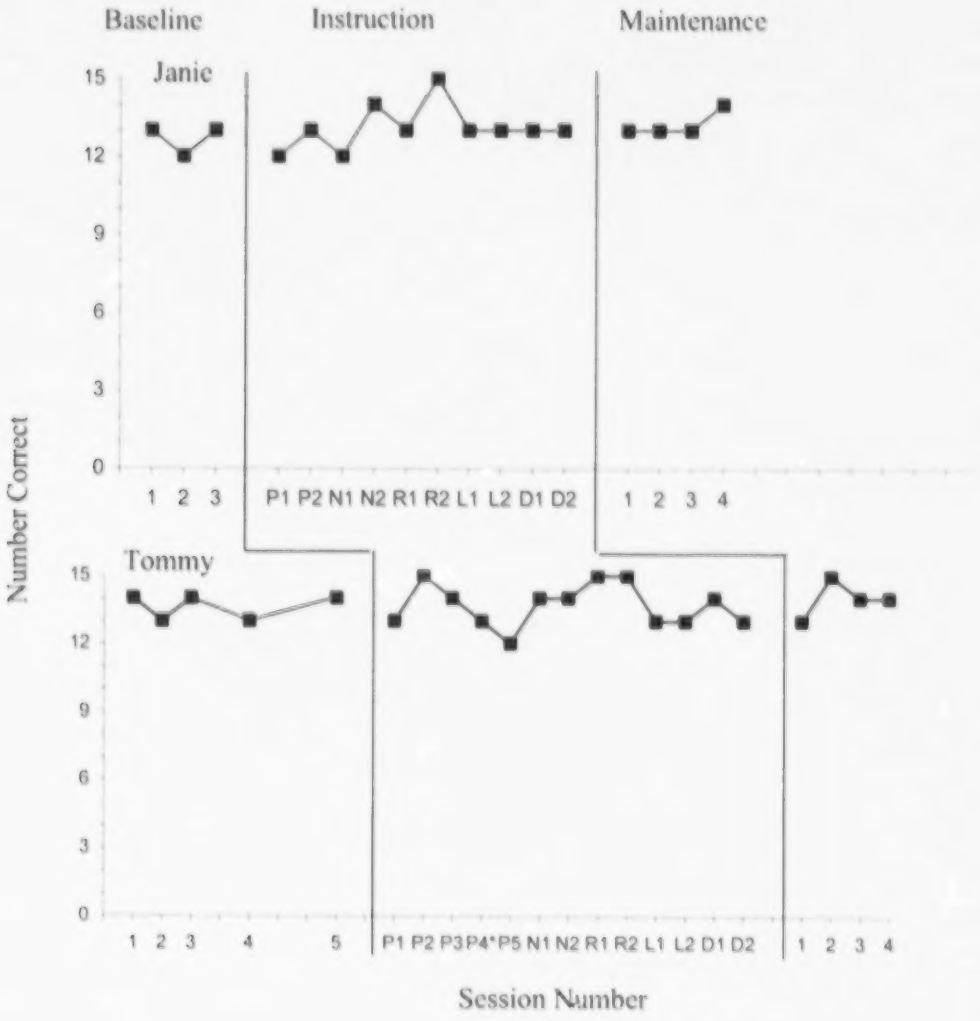


Table 8. Percentage of correct selections of initial and final letters during writing tasks probes for Janie and Tommy during baseline and maintenance.

Session	Janie		Tommy	
	Initial	Final	Initial	Final
Baseline 1	100%	0%	100%	0%
Baseline 2	80%	0%	100%	0%
Baseline 3	80%	0%	100%	0%
Baseline 4	---	---	80%	0%
Baseline 5	---	---	100%	0%
Maintenance 1	80%	80%	80%	100%
Maintenance 2	80%	100%	100%	100%
Maintenance 3	80%	100%	100%	100%
Maintenance 4	80%	100%	100%	100%

(i.e., with a range of 80%-100%). Furthermore, she often attempted additional letters (e.g., a vowel between the initial and final letters, a consonant after the initial letter for a blend).

During baseline, Tommy had a level of accuracy of 0% for the selection of final letters; he attempted the initial letter of the words with at least 80% accuracy (i.e., with a range of 80%-100%). During maintenance, he achieved an accuracy of at

least 80% (i.e., with a range of 80%-100%) for the selection of final letters. Unlike Janie, Tommy did not attempt additional letters in the medial positions of words in his stories.

DISCUSSION

Acquisition and Maintenance

The results of Study 2 demonstrated that the instructional program targeting the selection of final letter that was developed specifically for children who use AAC was effective for the two participants, Janie and Tommy. Janie was successful in acquiring the selection of final letters of words. In addition, she demonstrated maintenance of the target skill for at least one month following instruction. Tommy also demonstrated success in the acquisition of the target skill, and maintenance of the skill at least one month following instruction. Both participants applied the target skill to writing experiences and maintained an accuracy in the writing tasks with at least 80% accuracy. As was discussed in Study 1, the results of Study 2 are consistent with the literature supporting the ability of children with limited speech to acquire phonemic awareness skills despite significant articulation difficulties (e.g., Dahlgren Sandberg & Hjelmquist, 1996; Foley & Pollatsek, 1999).

The instructional approach used in this program appeared to be effective in facilitating the acquisition and maintenance of the target skill. The effectiveness may be attributed to the design of the instruction, as was discussed in Study 1. The children were provided with multiple opportunities for instruction in the target skills, review of previously learned skills, and application of the skill to writing tasks. The instruction activities were structured as play-type of activities, which may have

contributed to the participants' motivation and success.

Although Janie required only two sessions to achieve the criterion accuracy for each of the five target letters, Tommy demonstrated difficulty acquiring the first target letter. During the instructional activities addressing the selection of final letter, Tommy demonstrated difficulty only selecting the final letter of a word; he typically selected the initial letter and final letter. In the activities requiring the selection of initial and final letters, he was successful in selecting both the initial and final letters. When the instructional program was modified so that he was shown the written word (i.e., with the target letters covered) at the same time as the instructor presented the oral model of the word and pointed to the target position, he was successful in reaching the criterion accuracy. This suggests that Tommy required additional instruction in learning the concepts of 'first' and 'last'. The addition of this step in the instructional program may be required for some children who are unable to distinguish the two concepts and could easily be incorporated in the prompting hierarchy for future studies.

Generalization

Both of the participants demonstrated some generalization of the target skill (i.e., approximately 30%). A measure of generalization of the selection of initial letter with the two participants demonstrated that Tommy and Janie were at least 80% accurate. Since they were successful in generalizing the selection of initial letter (i.e.,

a skill they have mastered over a longer period of time), it is possible that Tommy and Janie required more time to generalize the selection of final letter. Tommy and Janie had only acquired the selection of final letter with five letters; therefore, with additional practice of the target skill with a wider pool of letters, over a longer period of time, Tommy and Janie may generalize the target skill. As discussed in Study 1, inclusion of an activity providing instruction and practice in generalization of the skill may facilitate generalization of the skill for Janie and Tommy. Specifically, the inclusion of an activity in which the participants were not provided with the oral models of the words prior to their response would not be difficult to incorporate into the instructional program. It would provide the children with opportunities to learn and practice subvocal articulatory rehearsal, which may facilitate the development of independent writing (e.g., Foley, 1993).

CHAPTER 4

DISSEMINATION OF RESULTS

The participants' parents and the professionals working with the participants (e.g., teachers, therapists, paraprofesionals) were provided with a summary of the results of the research project. They were also provided with the writing instructional materials in order to support the continuation of the writing instructional program at school. Furthermore, the professionals working with participants were provided with the materials in order to provide opportunities to introduce the writing instructional program with other individuals in their classes or on their caseloads.

The results of the research studies were disseminated at both state and national conferences so that the information could be shared with families, researchers, and professionals working with children who require the use of augmentative and alternative communication. The information was made accessible on the Internet to facilitate the dissemination of the information. And finally, resource packets of information are available for direct mailings to interested parents, educators, consumers, and related professionals. Upon request, the materials will also be made accessible in specific alternate formats to accommodate individuals with disabilities.

CHAPTER 5

LIMITATIONS AND FUTURE DIRECTIONS

One of the major limitations of the study is the small number of participants included in the two studies. The small number of participants seriously limits the generality of the results to a wider population of individuals who use AAC. Future studies should include a larger number of participants with a wider variety of disabilities to provide additional support for the effectiveness of the writing instructional programs across populations of individuals who use AAC.

The instructional program was developed as a package of activities targeting several skills; therefore, it is impossible to tease apart the effects of one instructional approach compared to the other. The current research suggests that children who use AAC who are at risk for the development of functional literacy skills may require additional explicit instruction in target skills. It is not clear how much additional direct instruction is necessary. Furthermore, it is not clear which skills are most important to emphasize in instruction. Future research should investigate the specific components of the instructional package and the instructional approaches to improve the efficacy of the program.

One of the challenges in designing the writing workshop-type activity for the participants in Study 1 and Study 2 was determining the scope of the stories the children would write. It was necessary to limit the scope of the stories so that the

target words could be identified easily. It was also critical to incorporate the target letters into the words attempted in either the initial or final positions to measure the participants' generalization of the acquired skills to writing tasks. Allowing the participants some flexibility in writing their own stories was also important. The result was that the participants were provided with multiple options of single words for each picture in the stories. It is not clear whether the participants would have preferred to choose words other than those provided by the instructor. A more child-directed approach to the writing workshop-type activity should be investigated in future studies.

Another direction for research in the development of effective writing instructional programs is the investigation of the factors that contribute to success in the generalization of the selection of initial and final letters to tasks in which the participants are not provided with an oral model by the instructor. Future research is needed to investigate the effectiveness of incorporating an additional step into the instructional program to provide explicit practice in selection of initial or final letters without an oral model being provided by the instructor. This may facilitate more independent writing for the participants.

A large pool of words was required for the study to prevent the memorization of the initial and/or final letters of words. Therefore, in order to generate a large enough pool, two syllable, low incidence words with greater semantic complexity for the participants' development levels were incorporated. Ideally, the instructional stimuli would have been restricted to one syllable, simpler words. This may be a

reason some of the participants had difficulty in generalizing the selection of initial or final letters of words, and is a limitation of the study. Additional research should investigate the effect of a similar writing instructional program with more developmentally appropriate words.

A limitation of the study was the length of the sessions. The instructional program consisted of a number of activities targeting several skills. These skills were delivered as a package and each instructional session targeted all of the skills. Gary was unable to acquire the selection of initial letter, letter-sound correspondence, and selection of the initial letter of words in non-dictation types of tasks. He demonstrated success when he was receiving instruction in one skill, letter-sound correspondence. It may have been more effective to teach each skill to mastery (i.e., letter-sound correspondence first, then selection of initial letter, and finally selection of initial letter in non-dictation types of tasks). Future research should investigate alternative approaches to teaching the three skills.

A final limitation of the study involves the design of the adaptive keyboard that was used in the activities. There was an array of 36 letters and the five target letters of instruction were highlighted. Having the five letters highlighted may have limited the responses of the children so that they were selecting letters from only the five highlighted letters. Future research should investigate a repetition of the current study without the target letters highlighted to determine any influence of the highlighted letters.

CHAPTER 6

SUMMARY

In conclusion, the findings of the Study 1 and Study 2 suggest that children who use AAC and who are at risk for the development of functional literacy skills, may acquire and maintain phonemic awareness skills (i.e., selection of initial and final letters) of orally presented words through participation in an instructional program that incorporates both a direct instruction approach and a whole language approach.. Furthermore, the results suggest that children who use AAC may be able to apply the target skills to writing experiences.

The program was not successful with all of the participants, therefore, additional support (i.e., the inclusion of more modeling and prompts) or additional opportunities for practicing the target skill may be required in the instructional program. Most of the children demonstrated some generalization of the target skills; however, inclusion of instruction in selecting the initial or final letter when not provided with the oral model by the instructor may have facilitated more success for the children. There were several other limitations to the study and many areas that need further investigation.

Overall, the results were very positive and consistent with the literature suggesting instructional approaches, including a balanced approach, that may be helpful for children at risk for the development of literacy skills and children with

limited speech skills (e.g., Graham & Harris, 1994; Traweek & Berninger, 1994). The success of the children participating in the instructional programs provides further evidence that children who use AAC are capable of learning phonemic awareness and letter-sound correspondence, and applying the early writing skills to literacy experiences given access to an instructional program.

CONCLUSION

This project was the first study investigating the effectiveness of a writing instructional program with children who use AAC. It is critical that research continue to investigate best practices for writing instruction with children who use AAC. It is critical that the number of children who use AAC graduating from high school with functional literacy skills increases significantly. It is imperative that future research projects include older children and adults who use AAC so that they, too, are able to pursue educational and vocational opportunities.

There are many questions remaining about writing instruction for children who use AAC. Educators, therapists, and other professional are desperate for empirically-validated instructional programs for children who use AAC. The research must continue in the area of literacy instruction for children who use AAC so that children who use AAC have the choice participate in all aspects of our highly literate society.

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Appendix A

Study 1: Organization of Words for Instructional Stimuli and Probes

Instruction

	S	D	C	F	B
Segmentation	sandwich	daytime	cage	factory	ballet
	sea	diaper	canoe	family	bandaid
	sick	disk	carriage	forget	beaver
	sitting	duck	cockroach	forklift	berries
	sundae	dumptruck	catch	full	bottle
	suckers	dunk	cougar	feather	bird
	safe	dad	cobweb	feed	bow
	see	daughter	comb	finger	bowl
	sister	deer	copy	fish	bucket
	sofa	dentist	correct	football	bushes
	subway	dirty	cough	fudge	butter
	surgeon	duckling	cute	funnel	bus
Writing Workshop	sandwich	daytime	cage	forget	ballet
	sea	diaper	carriage	full	beaver
	sitting	disk	cockroach	funnel	bottle

Probes

	Baseline 1	Baseline 2	Baseline 3
Segmentation	Donald	bunny	cabin
	box	bacon	season
	sack	sour	sour
	cowboy	cast	dice
	dice	cold	bag
	baboon	dollar	fight
	far	dust	count
	Saturn	furry	bookshelf
	cold	film	first
	baseball	cabin	sausage
	camping	bat	fan
	soup	fog	beanbag
	desserts	cartoon	sip
	seahorse	digging	dove
	bell	firetruck	desert
	cutting	salad	five
	feelings	sip	candy
	fan	carve	beach
	cookout	season	feelings
	divers	feelings	salad
	fox	dustpan	coat
	bagel	sausage	dumbbell
	faucet	dinner	bunny
	diamond	beans	desk
	sailing	box	camping
Writing Workshop	first	denim	coffee
	costumes	fight	fair
	bunny	count	sandal
	sailor	sandal	dark
	dishes	bait	bed

	Baseline 4	Baseline 5
Segmentation	doughnuts	firefly
	bunny	scissors
	cactus	sock
	Daffy	few
	cookout	bubbles
	footprint	desk
	bowling	salad
	seven	cassette
	cast	bath
	fair	bike
	bank	seahorse
	dishes	catcher
	cuddle	fasten
	cab	Donald
	soda	boot
	denim	daisy
	fasten	Dumbo
	dustpan	funny
	bulb	sour
	fire	beans
	same	denim
	fox	film
	sign	cab
	baseball	cookout
	suitcase	camel
Writing Workshop	fast	busy
	dice	secret
	bat	donkey
	concert	fox
	said	cake

	Instruction 1	Instruction 2	Instruction 3
Segmentation	fire	said	binder
	dinner	baseball	season
	cookies	falcon	dent
	bank	fog	darts
	beard	sandal	car
	dishes	cards	five
	cowboy	finish	finish
	baseball	cuddle	sip
	bait	dishes	seal
	scissors	dustpan	beanbag
	season	bald	bag
	fair	sign	salad
	coffee	seal	dizzy
	desk	bait	count
	first	Dwarf	foot
	seeds	dust	corner
	cuddle	boot	dolphin
	denim	count	cake
	bulb	book	diamond
	fat	dishrack	firetruck
	camera	cookout	salt
	divide	furniture	banjo
	footprint	concert	cabin
	secret	surfers	bear
	suitcase	fossil	few
Writing Workshop	bounce	bear	beans
	bowling	bed	bored
	busy	bike	bubbles
	cash	candy	calf
	corner	cab	camping
	costumes	cupcake	cards
	daisy	divers	dairy
	dumbbell	doughnuts	divers
	Dwarf	Dumbo	dustpan
	fight	far	field
	folders	fast	first
	fossil	forehead	furniture
	seven	sobbing	sailor
	salt	salt	surfers
	surfers	sausage	soda

Segmentation	Instruction 4	Instruction 5	Instruction 6
	carrot	forest	fast
	farmer	seeds	dizzy
	dice	four	donkey
	bald	fossil	busy
	seashell	forehead	beachball
	Diane	sailor	surfers
	doorbell	daisy	cash
	cash	cake	fox
	dairy	barber	food
	bounce	cards	cookies
	car	calf	camera
	sink	banjo	barber
	cold	Diane	basket
	suit	beach	dust
	book	sip	soup
	dark	six	fossil
	soup	fight	Daffy
	fold	seesaw	secret
	fan	cowboy	cutting
	calf	bat	fold
	fast	dust	suit
	bed	beanbag	suitcase
	fire	door	bulb
	bat	candy	down
	sack	dishrack	candle
Writing Workshop	banjo	bank	bear
	bear	bookshelf	book
	bookshelf	bounce	bounce
	camera	cabin	cast
	candy	camping	cab
	carry	cannon	corner
	Daffy	divide	dark
	dots	dizzy	denim
	dove	Dwarf	desert
	faucet	field	film
	fist	firetruck	footprint
	forehead	fog	forest
	seeds	salt	soldier
	salt	sandal	seven
	seven	secret	said

	Instruction 7	Instruction 8	Instruction 9
Segmentation	dumbbell	furry	bank
	food	seeds	cupcake
	sock	corner	bowling
	dove	sink	sobbing
	fasten	bowling	doctor
	sailing	bat	dinner
	busy	falcon	surfers
	sink	Dumbo	Daffy
	four	soldier	Saturn
	suit	forehead	car
	cold	dots	foot
	car	doorbell	fog
	cane	barber	corner
	desert	bait	dent
	divide	cake	baboon
	bounce	dust	book
	fossil	concert	syrup
	bagel	fist	bell
	coffee	cab	dust
	scissors	salt	coat
	carry	beard	suitcase
	bored	calf	cane
	build	dishrack	film
	fair	seesaw	field
	deaf	firetruck	fold
Writing Workshop	baboon	baby	beanbag
	baby	beachball	binder
	bowling	book	bulb
	candle	catcher	calf
	carve	cool	cool
	costumes	count	curtains
	denim	darts	dishrack
	desserts	doctor	door
	Donald	donkey	dustpan
	fat	fair	fat
	folders	faucet	feelings
	forehead	fossil	first
	sour	sailor	seesaw
	syrup	seal	Santa
	silly	same	sunshine

	Instruction 10	Instruction 11	Instruction 12
Segmentation	seal	candy	donkey
	baboon	cannon	funny
	down	box	box
	desk	said	baseball
	bag	banjo	digging
	count	dumbbell	forest
	bacon	sunshine	darts
	seashell	five	Donald
	birthday	sausage	sobbing
	Daffy	cash	bagel
	sailing	fight	fireman
	fog	cookout	Santa
	sink	dark	coffee
	dark	sign	carrot
	cupcake	bagel	foot
	desert	fan	build
	fist	bike	beach
	fire	fox	suit
	bed	cactus	same
	finish	daisy	cutting
	cabin	dishes	curtains
	fast	dove	fast
	Saturn	bell	cactus
	camel	sack	sour
	camera	first	dice
Writing Workshop	bat	bacon	bald
	bounce	beard	banjo
	build	bunny	basket
	calf	cake	cannon
	coat	cartoon	cast
	cookies	cassette	cowboy
	desserts	deaf	dent
	dolphin	dent	divide
	dustpan	donkey	doctor
	faucet	faucet	fair
	fireman	forehead	fist
	footprint	funny	footprint
	scissors	suitcase	sailor
	six	silly	seashell
	seven	Saturn	sack

	Instruction 13	Instruction 14	Instruction 15
Segmentation	birthday	cannon	feelings
	catcher	firetruck	boot
	divers	bed	film
	carrot	deaf	busy
	doorbell	cuddle	desserts
	camera	firefly	deaf
	dinner	folders	far
	five	dice	dolphin
	seahorse	bank	carve
	soldier	catcher	sign
	silly	cards	Dwarf
	same	Dumbo	baboon
	forest	cool	suit
	bike	sunshine	cold
	beard	funny	coffee
	few	beard	soldier
	soup	soldier	cowboy
	carve	daisy	down
	Donald	saddle	six
	barber	down	saddle
	cookies	bath	firefly
	fasten	fence	binder
	down	six	barber
	fist	sip	cactus
	bubbles	baby	folders
Writing Workshop	bald	bear	bath
	beachball	birthday	birthday
	beanbag	bored	bored
	cactus	cactus	camel
	cookout	carve	cannon
	cupcake	costumes	cab
	dairy	desserts	digging
	dent	dishes	door
	dove	dots	doughnuts
	fight	falcon	fireman
	firefly	five	four
	furry	food	furniture
	sip	Santa	silly
	sock	soda	Santa
	syrup	said	syrup

	Instruction 16	Instruction 17	Instruction 18
Segmentation	cartoon	divide	doughnuts
	food	finish	far
	bubbles	door	faucet
	syrup	barber	beachball
	camping	curtains	beans
	bag	bath	seahorse
	dairy	sunshine	foot
	soup	bagel	bookshelf
	bank	sausage	fold
	divers	bulb	Dumbo
	curtains	folders	seashell
	soda	field	curtains
	season	furniture	sandal
	divide	cutting	beanbag
	basket	camping	suitcase
	carry	firefly	bald
	sobbing	sign	dollar
	camel	dots	dumbbell
	few	beach	candle
	fold	cassette	concert
	fist	camel	diamond
	dolphin	soda	cartoon
	fence	divers	fireman
	door	sailing	soup
	baseball	dollar	cards
Writing Workshop	baby	binder	bacon
	bell	boot	beard
	binder	bored	bowling
	car	cabin	cane
	cassette	candle	carry
	cookies	coat	cool
	desk	desert	dizzy
	Diane	doorbell	doctor
	dinner	dove	dots
	fan	farmer	fat
	farmer	fence	finish
	furniture	fold	four
	secret	saddle	soda
	sandal	Santa	silly
	sunshine	sock	syrup

	Instruction 19	Instruction 20
Segmentation	boot	cool
	scissors	digging
	same	dishrack
	dolphin	fence
	cutting	cassette
	saddle	dizzy
	cool	cartoon
	seal	furry
	dollar	sobbing
	bacon	cuddle
	cast	cookies
	salad	birthday
	build	fire
	furniture	fireman
	doorbell	daisy
	bath	surfers
	bald	sailor
	fence	doctor
	digging	bell
	cartoon	seesaw
	foot	bed
	dishrack	basket
	concert	sign
	few	food
	falcon	binder
Writing Workshop	baby	beach
	basket	bike
	beach	box
	camel	candle
	carry	cash
	cassette	concert
	darts	diamond
	Diane	Diane
	Dwarf	Dwarf
	fat	farmer
	field	forest
	funny	four
	Santa	sock
	sink	sack
	sour	saddle

	Maintenance 1	Maintenance 2	Maintenance 3
Segmentation	cast	secret	six
	box	fireman	bait
	cupcake	cane	fasten
	donkey	bookshelf	coffee
	footprint	desk	same
	forest	cake	cowboy
	sack	seashell	foot
	fan	farmer	car
	cane	Donald	seahorse
	catcher	costumes	fox
	darts	bath	desert
	busy	sock	doughnuts
	falcon	coat	few
	sailing	baby	carve
	build	diamond	seal
	scissors	far	firefly
	dollar	food	bear
	seesaw	basket	Daffy
	candy	fat	dairy
	furry	seahorse	seeds
	banjo	sink	bulb
	Dumbo	dinner	cuddle
	bubbles	down	bag
	Saturn	beachball	deaf
	doughnuts	camera	Bubbles
Writing Workshop	silly	dairy	five
	bell	furry	cupcake
	deaf	seesaw	salad
	carrot	carrot	dent
	fasten	beans	book

Generalization 1	Generalization 2
color	cobra
biscuits	bench
singer	carpet
backpack	surprised
fawn	corn
curly	fixing
belt	file
follow	baker
find	bam
cap	fall
soccer	cone
dip	silver
deck	seat
different	doghouse
bull	cushion
soggy	device
foil	sax
castle	bark
cabbage	boat
dime	face
balloons	sore
fairy	dock
dog	dance
soap	fun
sewing	daydream

Appendix B

Study 1: The Instructional Program: Initial Letter

Overview

Part I – Introduce the target letter
Part II – Letter-sound correspondence
Part III – Selection of initial letter
Part V – Writing workshop-type activity

PART I: INTRODUCE TARGET LETTER

Goal

To introduce the letter that will be the target of the entire session and provide a brief description of the tasks.

Procedures

Step	Instructor
1	• Today we are going to learn about the letter ____. • First, we will talk about the sound that the letter ____ makes. • Second, we will look at some words that begin with the letter ____. • And the last activity we will do is use a keyboard with lots of letters to write a story to put in your storybook. • Let's start!

PART II: LETTER-SOUND CORRESPONDENCE

Goal

To teach letter-sound correspondence for the target letter. There will be one target letter per session. Previously targeted letters will be incorporated as distractors.

Procedures

Step	Instructor
1	• Now we are going to play a game matching sounds and letters. • Here is the letter ____. [Instructor holds up index card with the letter ____.] • The letter ____ makes the sound ____.
2	• [Instructor keeps holding up letter] • First, I will say the sound the letter ____ makes. • ____ (says target sound)
3	• [Instructor keeps holding up letter] • The letter ___ makes the sound ___ .
4	• Now, let's try it together. • The letter ___ makes the sound ___.
5	• Now, let's try it together again. • The letter ___ makes the sound ___.
6	• Let's find the letter on your keyboard. We are going to color it so we can find it later. • Here is the letter we are looking for [Instructor holds up the index card with the letter on it].
7	• This is the letter ___ (points to letter on keyboard). • Remember the letter ___ makes the sound ___. • Let's make the computer say the sound (push letter)
8	• Let's color it (provides visual prompt)
9	• Now, let's play the game. Here is a pile of cards. First, I'll pick a card. There is a letter on here, but I'm not going to show it to you. I'll tell you the sound it makes and you find the letter that makes the sound on your keyboard. • Every time you get one right, you get to hold on to the card and put it in your pile. If you don't get it right, it goes in my pile. At the end of the game, we'll count up how many you get right to see if you win!
10	• Find the letter that makes the sound ___. • [Instructor pushes letter if child uses partner assisted scanning] • If child is correct, "Hooray! That's right! You found the letter ___ that makes the sound ____." • If child is incorrect, "That was the letter ___ and it makes the sound ____. We are looking for the letter ___ and it makes the sound ___. Here is the letter ____. Listen, it makes the sound ____. [Instructor pushes letter]. Now you push it. [If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it.]
11	• Let's do it again! Let's see what the next one is. Find the letter that

	makes the sound ___. • If child is correct, "Hooray! That's right! You found the letter ___ that makes the sound ____." • If child is incorrect, "That was the letter ___ and it makes the sound ____. We are looking for the letter ___ and it makes the sound ___. Here is the letter ____. Listen, it makes the sound ____. [Instructor pushes letter]. Now you push it. [If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it.]
12	• [Instructor repeats step 10 until all 6 examples of the target letter and 3 examples of each distractor are completed]

PART III: SELECTION OF INITIAL LETTER

Goal

To teach selection of the initial letter in a word given an entire array of letters (i.e., the alternate keyboard used in the writing workshop-type activity).

Procedures

Step	Instructor
1	• Now, let's play another game. This one is a card game. • Here are some cards with pictures on them. • On the back of the card is the letter that is at the beginning of the word.
2	• Here is the pile of cards. Let's do the first one together. • First, I'll pick a card. • [Instructor holds up the first card] This is ____. (names picture) • Then, you need to find the first letter in ____ using your keyboard. • So, listen to the word ____. (elongates and segments the first sound)
3	• What letter do you hear at the beginning of ____? _____ (repeats word, elongates (or stresses) and segments the first sound) • ____ (says the sound)… that is the letter ____. • Let's find the letter ____ that makes the ____ sound.
4	• Here it is. You push the button so we can hear it. [[If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it .]. Here is the letter ___ on the screen.
5	• Now, let's see if we're right. [Instructor flips card over] • Hooray! Every time you get one right, you get to hold on to the card and put it in your pile. If you don't get it right, it goes in my pile. At

	the end of the game, we'll count up how many you get right to see if you win!
6	• Now we'll put that card back in the pile. • Do you understand how to play?

- There are three levels of scaffolding:
  1. Full prompting – elongate (approximately 0.5-1 second for fricatives) or stress (for stops), and segment (approximately 0.5-1 second pause) the first sound
  2. Partial prompting – elongate (approximately 0.5-1 second for fricatives) or stress (for stops) the first sound
  3. No prompting

FULL PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____. (elongates or stresses, and segments the first sound)
- Find the first letter in ____ (elongates or stresses, and segments the first sound)
- [Instructor flips over card]
- If child is correct, "That's right! The first letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Here is the whole word _____."
- If child is incorrect, "That was the letter ___ and it makes the sound ____. The first letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Now you push it." [If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it.] Here is the whole word _____."

PARTIAL PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____. (elongates the first sound)
- Find the first letter in ____ (elongates the first sound)
- If child is correct, "That's right! The first letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Here is the whole word _____."
- If child is incorrect, "That was the letter ___ and it makes the sound ____. The first letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Now you push it. [If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it.] Here is the whole word _____."

NO PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____.
- Find the first letter in ____
- If child is correct, "That's right! The first letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Here is the whole word _____."
- If child is incorrect, "That was the letter ___ and it makes the sound ____. The first letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Now you push it. [If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it.] Here is the whole word _____."

- There will be 12 examples of the target sound, and 3 examples of each previously targeted sound.
- For the target sounds, a most-to-least hierarchy of prompts will be provided in the following way:
  - The first target will be provided with full prompting.
  - If correct, the second target will be provided with partial prompting.
  - If correct the third target will be provided without prompting.
  - If correct, the fourth target will be provided without prompting.
  - If correct, the fifth target will be provided without prompting.
  - If correct, the sixth target will be provided without prompting.
- If at any point, the child provides an incorrect response, a correction procedure is provided and the next target is provided with a full prompt. If the next target is correct with a full prompt, the partial prompt is provided for the next target, and the hierarchy is followed for the remaining target examples.

- For the previously targeted letters (i.e., distractors), there are no prompts provided. If the child responds incorrectly, a correction procedure is provided and the item is repeated.

PART IV: WRITING WORKSHOP-TYPE ACTIVITY

Goal

To provide instruction in writing in the format of a writing workshop-type activity.
To provide support in applying letter-sound knowledge and selection of initial sounds to novel writing.

Procedures

Step	Instructor
1	• Now, we are going to use the keyboard and the computer to write a story.
2	• First, I'm going to make up a story. Here are the pictures for my story. [Instructor labels each picture (3 pictures + one of instructor)]. • [Instructor chooses one picture at a time, starting with the picture of herself, and puts it on the Velcro story strip. The instructor tells a story looking at each picture with the child; the instructor provides one sentence about each picture describing who is in the picture and what is happening.]
3	• Now, it's your turn! • I want you to write a story about yourself using these pictures. If you don't know how to spell a word, you can just write the first letter of the word.
4	• I want you to start with the picture of yourself since the story is about you. [Instructor puts the picture of the child on the strip]. • Now let's see, what happens next in your story? [Child chooses a picture]. • What will you write? You could write ____ [Instructor provides choices of words representing the picture and then goes through them to find the target word]. • All right, you're going to write ____. • [The child writes the word. The instructor provides help if the child requires partner assisted scanning.]
5	• What happens next in your story? [Child chooses a picture]. • What will you write? You could write ____ [Instructor orally provides choices of words representing the picture and then goes through them to find the target word]. • All right, you're going to write ____. • [The child writes the word. The instructor provides help if the child requires partner assisted scanning.]
6	• [Instructor repeats step 5 for the last picture.]
7	• What a great story! Let's see what you wrote about. [The

	instructor writes the correct spelling of the target words below the story under the picture. The instructor models the letter-sound correspondence and segmentation for the initial sounds. Instructor tells a silly story linking the child's words to model more complex story writing]

Appendix C

Study 1: Sample Data for Selection of Initial Letter in a Writing Task

Melinda:

Session	Picture 1	Picture 2	Picture 3	Picture 4	Picture 5
Baseline 1	a (costumes)	g (first)	g (bunny)	a (dishes)	au (sailor)
Baseline 2	f (sandal)	u (ferriswheel)	a (coffee)	f (bed)	f (dark)
Maintenance 1	s (silly)	f (fasten)	d (deaf)	f (bell)	c (carrot)
Maintenance 2	b (book)	s (salad)	d (dent)	c (cupcake)	f (five)

Haley:

Session	Picture 1	Picture 2	Picture 3	Picture 4	Picture 5
Baseline 2	a (coffee)	a (fair)	a (sandal)	a (dark)	a (bed)
Baseline 3	aa (concert)	a (fast)	a (dice)	a (said)	g (bat)
Maintenance 3	b (cupcake)	s (salad)	b (book)	d (dent)	f (five)
Maintenance 4	f (fasten)	s (silly)	d (deaf)	b (bell)	c (carrot)

Gary:

Session	Picture 1	Picture 2	Picture 3	Picture 4	Picture 5
Baseline 1	xxxrwy (costumes)	x (first)	x (dishes)	xs (sailor)	pj (bunny)
Baseline 3	l (coffee)	h (sandal)	u (bed)	h (dark)	pk (fair)

Appendix D

Study 2: Organization of Words for Instructional Stimuli and Probes

Instruction

	P	N	R	L	D
Segmentation	sleep	sign	color	stool	bad
	jeep	surgeon	surfer	foil	seed
	tulip	fasten	soccer	pail	red
	cap	seven	pear	bowl	F.ed
	clip	baboon	cougar	pull	snowed
	tip	can	finger	snail	food
	loop	rain	locker	tall	head
	syrup	cannon	barber	heel	feed
	scoop	bean	butter	seal	cried
	makeup	cartoon	hear	meal	cloud
	tap	falcon	lobster	pencil	flood
	lip	brown	diver	pill	good
Writing Workshop	tulip	can	lobster	seal	food
	cap	bean	pear	bowl	cried
	jeep	baboon	diver	stool	snowed

Probes: Selection of Final Letter

Baseline 1	Baseline 2	Baseline 3	Baseline 4
plaid	full	feather	lap
sneaker	sad	said	guitar
full	howl	clown	blood
beaver	small	call	step
racoon	moon	dollar	sad
won	dolphin	lid	sled
feather	wall	fossil	ten
ran	hip	town	wall
door	flip	won	mud
howl	bill	door	moon
hen	pour	sailor	slip
blood	sip	pour	bill
sip	floor	racoon	bread
clean	feather	bacon	banner
mop	zip	plaid	snip
ball	leap	slip	father
spill	bread	lap	deep
loud	bacon	step	button
jail	railroad	sad	hanger
step	mud	deep	door
hip	hen	bead	clown
slip	cabin	sip	ball
bead	door	nail	ran
bread	sneaker	roll	call
corner	plaid	jail	nail

Instruction 1	Instruction 2	Instruction 3	Instruction 4
ten	top	guitar	nail
lid	gallop	banner	floor
flip	loud	feather	wall
wall	bagel	slid	spill
mad	father	jail	leap
jail	button	mud	cabin
spill	kitten	bill	bill
plaid	leap	rip	clean
dollar	clean	kitten	top
bead	clown	howl	lid
sip	cabin	full	clown
town	hip	wall	corner
toad	full	lid	town
floor	sweep	clean	flip
racoon	weed	sailor	zip
pool	spill	bacon	ball
clown	pal	slip	button
sailor	beaver	bread	gallop
clean	bead	plaid	banner
hanger	bill	dollar	hanger
full	guitar	sip	weed
father	sad	mop	burger
snip	mad	button	sled
lap	sailor	clown	loud
rip	burger	flip	mad

Instruction 5	Instruction 6	Instruction 7	Instruction 8
bacon	lid	nail	mop
beaver	father	mop	sled
pour	bead	fossil	lap
won	zip	step	ran
hen	gallop	guitar	bagel
four	blood	hanger	ten
fossil	town	floor	roll
guitar	sailor	sad	toad
clown	weed	lid	feather
hip	dollar	pour	sweep
slip	feather	four	corner
pal	sneaker	sip	banner
dolphin	fossil	bread	sailor
bread	sip	blood	father
said	ran	ball	howl
bead	plaid	bacon	pool
full	spill	leap	railroad
hanger	roll	toad	button
spill	wall	cabin	moon
jail	call	racoon	rip
mop	clean	rip	fossil
step	leap	full	small
loud	bacon	wall	loud
zip	button	coin	clean
plaid	step	town	said

Instruction 9	Instruction 10	Instruction 11	Instruction 12
won	ran	floor	flip
floor	slip	ball	slid
dollar	dollar	top	gallop
loud	loud	said	beaver
slip	bagel	burger	lap
bread	hip	jail	blood
banner	sweep	coin	ball
burger	lap	flip	sneaker
moon	floor	sweep	burger
weed	said	cabin	sad
pool	mud	pour	ran
hen	nail	rip	bill
mud	dolphin	father	toad
fossil	sailor	slid	banner
mad	pal	racoon	leap
father	roll	door	door
bagel	railroad	mud	said
ten	sled	spill	jail
bacon	gallop	moon	mop
lap	town	deep	howl
zip	ten	call	coin
step	door	pal	bagel
roll	moon	lid	ten
small	beaver	toad	dolphin
top	pool	kitten	kitten

Instruction 13	Maintenance 1	Maintenance 2	Maintenance 3
ten	sweep	corner	corner
mud	sad	flip	dolphin
burger	rip	won	kitten
mop	hanger	guitar	deep
sled	hip	beaver	sneaker
hen	gallop	hen	ball
said	slid	roll	sled
toad	nail	kitten	snip
won	dolphin	zip	nail
cabin	racoon	four	fossil
hip	railroad	racoon	pool
deep	weed	coin	slid
dollar	howl	burger	railroad
lap	four	pal	weed
top	coin	bill	town
four	pour	slid	pour
pal	hen	deep	small
howl	won	bagel	feather
coin	blood	toad	mad
blood	pal	small	four
call	sneaker	sweep	top
beaver	snip	weed	coin
guitar	call	railroad	ran
pool	corner	top	leap
roll	small	mad	zip

Generalization 1	Generalization 2
hill	sail
stop	muffin
played	pen
road	rowed
stain	flap
bull	cup
hair	toaster
kid	hood
fan	spoon
baker	mall
fell	hurried
man	towel
fair	hid
hop	doll
smell	map
skip	hoop
down	binder
doctor	farmer
catcher	mail
mowed	pan
fawn	soup
bed	silver
soap	singer
tool	sun
clap	salad

Probes: Selection of Initial Letter

Baseline 1	Baseline 2	Baseline 3	Baseline 4
dock	boot	cake	dots
last	hair	ball	game
ball	coat	sailor	last
rooster	ring	game	catch
moon	jungle	fast	ball
fawn	lego	dishes	tissue
jail	party	napkin	jeans
sister	marble	jam	sister
paint	gold	party	fawn
hair	tired	wall	rabbit
tiger	dots	lamp	none
witch	napkin	heel	hen
none	seven	moon	window
goose	four	rag	moon
coat	wheel	ten	peanut

Baseline 5	Instruction 1	Instruction 2	Instruction 3
coat	goat	moon	work
lamp	teeth	lamp	jam
rake	can	work	tiger
hot	joke	sailor	four
bell	laundry	napkin	rag
tissue	dots	tiger	gold
jungle	mouse	jail	line
dishes	boot	cake	cold
sister	rag	heel	needle
wheel	walrus	rake	mad
nail	nap	party	boat
marble	hot	fast	peach
penny	peach	gold	sun
foot	sick	doll	hair
goofy	fawn	boat	doll
coat	goat	moon	work
lamp	teeth	lamp	jam
rake	can	work	tiger

Instruction 4	Instruction 5	Instruction 6	Instruction 7
rain	hat	witch	heel
gate	coat	gate	tissue
doughnut	game	none	last
ball	boot	tissue	bell
cake	nail	can	nap
laundry	mouse	hammer	sun
fast	ring	bell	fell
sick	teeth	seven	witch
wall	window	doughnut	peach
tired	lamp	moon	goat
none	jail	party	jail
map	seven	fast	can
joke	peach	rag	marble
park	fell	last	doughnut
hair	doughnut	jail	ring
rain	hat	witch	heel

Instruction 8	Instruction 9	Instruction 10	Instruction 11
wall	boot	work	ten
nap	mad	can	nail
bow	paint	band	doughnut
peanut	nail	hot	peach
catch	walrus	jeans	sun
hen	teeth	sit	line
rooster	dots	four	cake
map	hammer	rabbit	foot
dock	rag	party	band
four	cake	marble	heel
last	line	teeth	walrus
jeans	sister	gate	joke
sister	four	needle	gate
goofy	goat	lamp	rabbit
tired	jar	dishes	mad
wall	boot	work	ten

Instruction 12	Instruction 13	Instruction 14	Instruction 15
rabbit	ring	mop	fell
dots	jar	cold	dock
penny	nap	band	tail
jar	ten	ten	seven
gate	bell	walrus	ring
ball	hair	sun	paint
tissue	witch	deep	boat
work	peanut	lamb	wheel
sit	map	line	mouse
catch	fast	jar	jar
note	goofy	heel	goose
line	dock	goose	cold
mop	seven	paint	nail
foot	cat	fell	hammer
hot	lamb	park	lamb
rabbit	ring	mop	fell

Instruction 16	Instruction 17	Instruction 18	Instruction 19
coat	dishes	boot	jungle
needle	hen	doll	tail
teeth	fawn	mad	needle
sailor	mop	lego	lego
laundry	bell	can	doll
goat	cold	sun	game
bell	lamb	goat	mouse
work	nap	needle	peanut
hot	joke	hammer	rain
park	sick	foot	wall
mouse	wall	ten	sick
joke	gold	penny	cat
fan	rake	rabbit	fan
doll	tail	wheel	hammer
rake	park	jungle	band
coat	dishes	boot	jungle

Instruction 20	Maintenance 1	Maintenance 2	Maintenance 3
gold	bow	bow	bow
park	rain	fan	penny
wheel	penny	peanut	rooster
jam	goose	note	window
foot	jam	tired	tail
note	catch	dishes	jungle
tiger	marble	lego	laundry
deep	lamb	sit	mop
band	sailor	goofy	goose
cold	deep	hat	fan
hat	hen	map	hat
mad	fawn	jeans	note
sick	napkin	rooster	cat
rain	tired	cat	deep
laundry	window	window	sit
gold	bow	bow	bow

Generalization 1	Generalization 2
water	fire
fat	gas
matches	saw
gum	man
candy	lake
nine	jump
head	cap
sack	wagon
jet	bag
bounce	tape
ladder	parrot
tent	hand
rope	neck
dog	dig
pear	run
water	fire

Instruction 9	Instruction 10	Instruction 11	Instruction 12
won	ran	floor	flip
floor	slip	ball	slid
dollar	dollar	top	gallop
loud	loud	said	beaver
slip	bagel	burger	lap
bread	hip	jail	blood
banner	sweep	coin	ball
burger	lap	flip	sneaker
moon	floor	sweep	burger
weed	said	cabin	sad
pool	mud	pour	ran
hen	nail	rip	bill
mud	dolphin	father	toad
fossil	sailor	slid	banner
mad	pal	racoon	leap
father	roll	door	door
bagel	railroad	mud	said
ten	sled	spill	jail
bacon	gallop	moon	mop
lap	town	deep	howl
zip	ten	call	coin
step	door	pal	bagel
roll	moon	lid	ten
small	beaver	toad	dolphin
top	pool	kitten	kitten

Instruction 13	Maintenance 1	Maintenance 2	Maintenance 3
ten	sweep	corner	corner
mud	sad	flip	dolphin
burger	rip	won	kitten
mop	hanger	guitar	deep
sled	hip	beaver	sneaker
hen	gallop	hen	ball
said	slid	roll	sled
toad	nail	kitten	snip
won	dolphin	zip	nail
cabin	racoon	four	fossil
hip	railroad	racoon	pool
deep	weed	coin	slid
dollar	howl	burger	railroad
lap	four	pal	weed
top	coin	bill	town
four	pour	slid	pour
pal	hen	deep	small
howl	won	bagel	feather
coin	blood	toad	mad
blood	pal	small	four
call	sneaker	sweep	top
beaver	snip	weed	coin
guitar	call	railroad	ran
pool	corner	top	leap
roll	small	mad	zip

Generalization 1	Generalization 2
hill	sail
stop	muffin
played	pen
road	rowed
stain	flap
bull	cup
hair	toaster
kid	hood
fan	spoon
baker	mall
fell	hurried
man	towel
fair	hid
hop	doll
smell	map
skip	hoop
down	binder
doctor	farmer
catcher	mail
mowed	pan
fawn	soup
bed	silver
soap	singer
tool	sun
clap	salad

Probes: Writing Workshop

Baseline 1	Baseline 2	Baseline 3	Baseline 4	Baseline 5
lid	cabin	dolphin	sailor	cabin
snip	hanger	ball	weed	zip
door	top	mad	hip	mad
ball	small	father	bacon	ball
dolphin	lid	slip	pool	door

P					
Instruction 1	**Instruction 2**	**Instruction 3**	**Instruction 4**	**Instruction 5**	**Instruction 6**
step	deep	sweep	gallop	rip	gallop
slip	step	deep	mop	snip	leap
sweep	sweep	flip	flip	lap	zip

N					
Instruction 1	**Instruction 2**	**Instruction 3**	**Instruction 4**	**Instruction 5**	**Instruction 6**
button	button	ten	hen	town	kitten
clean	coin	moon	raccoon	cabin	clown
clown	kitten	ran	won	ten	button

R					
Instruction 1	**Instruction 2**	**Instruction 3**	**Instruction 4**	**Instruction 5**	**Instruction 6**
beaver	feather	banner	four	corner	four
pour	sneaker	corner	hanger	dollar	pour
burger	sailor	guitar	sneaker	father	burger

L					
Instruction 1	**Instruction 2**	**Instruction 3**	**Instruction 4**	**Instruction 5**	**Instruction 6**
wall	pool	nail	fossil	bagel	call
bill	nail	full	wall	fossil	howl
call	full	small	bill	spill	pal

D					
Instruction 1	**Instruction 2**	**Instruction 3**	**Instruction 4**	**Instruction 5**	**Instruction 6**
railroad	blood	mud	slid	bread	slid
said	loud	sad	railroad	loud	mud
bead	mad	weed	plaid	sad	bread

Maintenance 1	**Maintenance 2**	**Maintenance 3**	**Maintenance 4**
mop	rip	sip	top
jail	small	roll	bagel
bacon	dolphin	moon	ran
floor	banner	dollar	sneaker
sled	toad	sled	bead

Appendix E
Study 2: The Instructional Program: Final Letter

Overview

Part I – Introduce the target letter
Part II – Selection of final letter
Part III – Selection of initial letter and final letter
Part V – Writing workshop-type activity

PART I: INTRODUCE TARGET LETTER

Goal

To introduce the letter that will be the target of the entire session and provide a brief description of the tasks.

Procedures

Step	Instructor
1	• Today we are going to learn about the letter ____. • First, we will look at some words that end in the letter ____. • Then we will look at more words and talk about the first and last letters. • And the last activity we will do is use a keyboard with lots of letters to write a story to put in your storybook. • Let's start!

PART II: SELECTION OF FINAL LETTER

Goal

To teach selection of the final letter in a word given an entire array of letters (i.e., the alternate keyboard used in the writing workshop-type activity).

Procedures

Step	Instructor
1	• Now, let's play a game. This one is a card game. • Here are some cards with pictures on them. • On the back of the card is the whole word and the last letter is really dark so you can see it. [final letter is in bold font]
2	• Here is the pile of cards. Let's do the first one together. • First, I'll pick a card. • [Instructor holds up the first card] This is ____. (names picture) • Then, you need to find the last letter in ____ using your keyboard. • So, listen to the word ____. (elongates and segments the final sound)
3	• What letter do you hear at the end of ____? _____ (repeats word, elongates (or stresses) and segments the last sound) • ____ (says the sound)… that is the letter ____. • Let's find the letter ____ that makes the ____ sound.
4	• Here it is. You push the button so we can hear it. [[If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it .]. Here is the letter ___ on the screen.
5	• Now, let's see if we're right. [Instructor flips card over] • Hooray! Every time you get one right, you get to hold on to the card and put it in your pile. If you don't get it right, it goes in my pile. At the end of the game, we'll count up how many you get right to see if you win!
6	• Now we'll put that card back in the pile. • Do you understand how to play?

- There are three levels of scaffolding:
  1. Full prompting – elongate (approximately 0.5-1 second for fricatives) or stress (for stops), and segment (approximately 0.5-1 second pause) the final sound
  2. Partial prompting – elongate (approximately 0.5-1 second for fricatives) or stress (for stops) the final sound
  3. No prompting

FULL PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____. (elongates or stresses, and segments the last sound)
- Find the last letter in ____ (elongates or stresses, and segments the last sound)
- [Instructor flips over card]
- If child is correct, "That's right! The last letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Here is the whole word _____."
- If child is incorrect, "That was the letter ___ and it makes the sound ____. The last letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Now you push it." [If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it.] Here is the whole word _____."

PARTIAL PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____. (elongates the last sound)
- Find the first letter in ____ (elongates the last sound)
- If child is correct, "That's right! The last letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Here is the whole word _____."
- If child is incorrect, "That was the letter ___ and it makes the sound ____. The last letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Now you push it. [If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it.] Here is the whole word _____."

NO PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____.
- Find the last letter in ____
- If child is correct, "That's right! The last letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Here is the whole word _____."
- If child is incorrect, "That was the letter ___ and it makes the sound ____. The last letter in ____makes the sound ____. It is the letter ____. ____ (says word and accesses letter on keyboard)____ (repeats sound.) Now you push it. [If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it.] Here is the whole word _____."

- There will be 12 examples of the target sound, and 3 examples of each previously targeted sound.
- For the target sounds, a most-to-least hierarchy of prompts will be provided in the following way:
  - The first target will be provided with full prompting.
  - If correct, the second target will be provided with partial prompting.
  - If correct the third target will be provided without prompting.
  - If correct, the fourth target will be provided without prompting.
  - If correct, the fifth target will be provided without prompting.
  - If correct, the sixth target will be provided without prompting.
- If at any point, the child provides an incorrect response, a correction procedure is provided and the next target is provided with a full prompt. If the next target is correct with a full prompt, the partial prompt is provided for the next target, and the hierarchy is followed for the remaining target examples.

- For the previously targeted letters (i.e., distractors), there are no prompts provided. If the child responds incorrectly, a correction procedure is provided and the item is repeated.

PART II: SELECTION OF INITIAL AND FINAL LETTERS

Goal

To teach selection of the initial and final letter in a word given an entire array of letters (i.e., the alternate keyboard used in the writing workshop-type activity).

Procedures

Step	Instructor
1	• Now, let's play another card game. • Here are some cards with pictures on them. • On the back of the card is the whole word and the first and last letters are really dark so you can see them. [the first and last letters are in bold font]
2	• Here is the pile of cards. Let's do the first one together. • First, I'll pick a card. • [Instructor holds up the first card] This is ____. (names picture) • Then, you need to find the first letter and last letter in ____ using your keyboard.
3	• Let's do the first letter. • What letter do you hear at the beginning of ____? _____

	(repeats word, elongates (or stresses) and segments the first sound) • ____ (says the sound)… that is the letter ____. • Let's find the letter ____ that makes the ____ sound.
4	• Here it is. You push the button so we can hear it. [[If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it .]. Here is the letter ___ on the screen.
3	• Let's do the last letter. • What letter do you hear at the end of ____? _____ (repeats word, elongates (or stresses) and segments the last sound) • ____ (says the sound)… that is the letter ____. • Let's find the letter ____ that makes the ____ sound.
4	• Here it is. You push the button so we can hear it. [[If the child uses partner assisted scanning, the child will scan through that row only to find it and then the instructor will push it .]. Here is the letter ___ on the screen.
5	• Now, let's see if we're right. [Instructor flips card over] • Hooray! Every time you get one right, you get to hold on to the card and put it in your pile. If you don't get it right, it goes in my pile. At the end of the game, we'll count up how many you get right to see if you win!
6	• Now we'll put that card back in the pile. • Do you understand how to play?

- There are three levels of scaffolding:
  1. Full prompting – elongate (approximately 0.5-1 second for fricatives) or stress (for stops), and segment (approximately 0.5-1 second pause) the final sound
  2. Partial prompting – elongate (approximately 0.5-1 second for fricatives) or stress (for stops) the final sound
  3. No prompting

FULL PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____.
- First, find the first letter in ____ (elongates or stresses, and segments the first sound)
- Now, find the last letter in ____ (elongates or stresses, and segments the last sound)
- [Instructor flips over card]
- [Instructor provides correction procedures for both initial and final letters in the same manner as previously described]

PARTIAL PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____.
- First, find the first letter in ____ (elongates or stresses the first sound)
- Now, find the last letter in ____ (elongates or stresses the last sound)
- [Instructor flips over card]
- [Instructor provides correction procedures for both initial and final letters in the same manner as previously described]

NO PROMPTING

- [Instructor picks card and holds up picture]
- Here's ___.
- Listen to the word ____.
- First, find the first letter in ____ (elongates or stresses the first sound)
- Now, find the last letter in ____ (elongates or stresses the last sound)
- [Instructor provides correction procedures for both initial and final letters in the same manner as previously described]

- There will be 12 examples of the target sound, and 3 examples of each previously targeted sound.
- For the target sounds, a most-to-least hierarchy of prompts will be provided in the following way:
  - The first target will be provided with full prompting.
  - If correct, the second target will be provided with partial prompting.
  - If correct the third target will be provided without prompting.
  - If correct, the fourth target will be provided without prompting.
  - If correct, the fifth target will be provided without prompting.
  - If correct, the sixth target will be provided without prompting.
- If at any point, the child provides an incorrect response, a correction procedure is

provided and the next target is provided with a full prompt. If the next target is correct with a full prompt, the partial prompt is provided for the next target, and the hierarchy is followed for the remaining target examples.

- For the previously targeted letters (i.e., distractors), there are no prompts provided. If the child responds incorrectly, a correction procedure is provided and the item is repeated.

PART IV: WRITING WORKSHOP-TYPE ACTIVITY

Goal

To provide instruction in writing in the format of a writing workshop-type activity.
To provide support in selection of initial and final sounds to novel writing.

Procedures

Step	Instructor
1	• Now, we are going to use the keyboard and the computer to write a story.
2	• First, I'm going to make up a story. Here are the pictures for my story. [Instructor labels each picture (3 pictures + one of instructor)]. • [Instructor chooses one picture at a time, starting with the picture of herself, and puts it on the Velcro story strip. The instructor tells a story looking at each picture with the child; the instructor provides one sentence about each picture describing who is in the picture and what is happening.]
3	• Now, it's your turn! • I want you to write a story about yourself using these pictures. If you don't know how to spell a word, you can just write the first and last letter of the word.
4	• I want you to start with the picture of yourself since the story is about you. [Instructor puts the picture of the child on the strip]. • Now let's see, what happens next in your story? [Child chooses a picture]. • What will you write? You could write ____ [Instructor orally provides choices of words representing the picture and then goes through them to find the target word]. • All right, you're going to write ____. • [The child writes the word. The instructor provides help if the child requires partner assisted scanning.]
5	• What happens next in your story? [Child chooses a picture]. • What will you write? You could write ____ [Instructor provides choices of words representing the picture and then goes through them to find the target word]. • All right, you're going to write ____. • [The child writes the word. The instructor provides help if the child requires partner assisted scanning.]
6	• [Instructor repeats step 5 for the last picture.]

7	• What a great story! Let's see what you wrote about. [The instructor writes the correct spelling of the target words below the story under the picture. The instructor models the letter-sound correspondence, segmentation for the initial sounds and final sounds. Instructor tells a silly story linking the child's words to model more complex story writing.]

Appendix F

Sample Data for Selection of Initial and Final Letters in a Writing Task

Janie:

Session	Picture 1	Picture 2	Picture 3	Picture 4	Picture 5
Baseline 1	l (lid)	d (door)	b (ball)	d (deep)	d (dolphin)
Baseline 2	h (hanger)	s (small)	m (mad)	s (cabin)	s (sweep)
Maintenance 1	jl (jail)	bn (bacon)	sd (sled)	fn (floor)	p (mop)
Maintenance 2	dr (dollar)	rol (roll)	std (sled)	p (sip)	mn (moon)

Tommy:

Session	Picture 1	Picture 2	Picture 3	Picture 4	Picture 5
Baseline 2	c (cabin)	h (hanger)	s (sweep)	c (small)	l (lid)
Baseline 3	d (dolphin)	b (ball)	m (mad)	d (door)	d (deep)
Maintenance 2	sd (sled)	fr (floor)	bn (bacon)	mp (mop)	jl (jail)
Maintenance 3	bd (bead)	sr (sneaker)	bl (bagel)	tp (top)	rn (run)